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LANDSAT 7 ETM+
LEVEL ZERO-R ARCHIVE (L0RA)
DATA FORMAT CONTROL BOOK (DFCB)

Version 10

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Executive Summary

This Data Format Control Book (DFCB) presents detailed data formats of the output files generated by the Landsat 7 Processing System (LPS). The LPS produces output files for each subinterval identified in a Landsat 7 contact period. The raw wideband data is received from the Data Capture System (DCS) or from International Ground Stations (IGS). Each subinterval consists of an Enhanced Thematic Mapper Plus (ETM+) Format 1 and Format 2 segment. The LPS output files include Level 0R files, a metadata file, and one or more multiband scene browse file(s). The Level 0R files include a band data file (integer-pixel aligned) for each band of the ETM+ instrument, a Mirror Scan Correction Data (MSCD) file, a Payload Correction Data (PCD) file, and a calibration data file. The LPS produces a separate set of Level 0R files for the ETM+ Format 1 and Format 2 subintervals. The LPS produces a total of six band data files (Bands 1–6) for an ETM+ Format 1 subinterval, and a total of three band data files (Bands 6–8, ignoring segmentation for Band 8) for an ETM+ Format 2 subinterval. The LPS produces multiband scene browse files for the ETM+ Format 1 subinterval only. The LPS may produce up to 35 full multiband scene browse files for a 14-minute subinterval. A metadata file is produced for each ETM+ format of a subinterval. The LPS uses the Hierarchical Data Format (HDF) for storing these files in the LPS.

This DFCB should be used in conjunction with the Landsat 7 System Data Format Control Book (DFCB), Volume IV - Wideband Data to get complete details on the band (ETM+ major and minor frame structures), the MSCD, the PCD (cycle, major frame, and minor frame organization), and the calibration (starting and ending minor frames for each band) data included in the LPS Level 0Ra output files.

Keywords: Data Format Control Book (DFCB), Landsat 7 Processing System (LPS)

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Section 1 Introduction

1.1 Purpose and Scope

This Data Format Control Book (DFCB) defines detailed formats of the output (Level 0R, metadata, and multiband browse) files generated by the Landsat 7 Processing System (LPS). The LPS makes these files available for archive to the Landsat Archive Manager (LAM) on a Landsat 7 contact period basis.

The LPS output file formats described in this DFCB are based on the requirements contained in the LPS System Requirements Document and the Interface Control Document (ICD) between the Landsat Archive Manager (LAM) Archive Server (AS) and the LPS.

This DFCB describes the data contents and Hierarchical Data Format (HDF) details for the LPS output files. The contents of the LPS output files defined in this DFCB are based on the Landsat 7 ETM+ instrument and Payload Correction Data (PCD) details contained in the Landsat 7 Data Format Control Book, Volume IV - Wideband Data, the LPS Systems Requirements Document (SRD) , and the HDF documents/specifications available from the National Center for Supercomputing Applications (NCSA).

The file formats contained in this DFCB are applicable to the interface between the LAM and the LPS. This DFCB does not contain specific details on the file formats for the Landsat 7 Level 0R products generally requested by the Landsat 7 users and provided by the LAM. Detailed formats for the Level 0R products, required by the Landsat 7 users, are defined in a separate document, the Landsat 7 L0R Distribution Product DFCB.

1.2 HDF Data Types

This DFCB contains the following data types:

HDF C Language Notation	Data Type	No. of Bytes
char8	8-bit ASCII character	1
Int8	8-bit signed integer	1
uint8	8-bit unsigned integer	1
Int16	16-bit signed integer	2
Uint16	16-bit unsigned integer	2
Int32	32-bit signed integer	4
Uint32	32-bit unsigned integer	4
float32	32-bit floating point number	4
float64	64-bit floating point number	8

Table 1-1. Data Types

In addition, the following terms are synonymously used to denote the length of a given data type field in an LPS and/or HDF data structure (Vdata, Swath, etc.):

Order: This term denotes the number of items of the Vdata type as shown. For example, if the data type is 'uint16' with an order of '2', the HDF field size is 4 bytes.

Count: This term denotes the number of items of the data type as shown.

Size: This term denotes the size of an LPS file attribute/field in total number of bytes.

Section 2 LPS Output Files Overview

2.1 Level 0R Files

The primary outputs of the LPS consist of Level 0R files, the metadata (file), and multiband scene browse files. The Level 0R files include ETM+ instrument band (image) data, Mirror Scan Correction Data (MSCD), PCD, and calibration data files. The band file(s) contain the Level 0R processed science data collected from the Landsat 7 ETM+ instrument. A Level 0R band file contains reformatted, unrectified, subinterval data having a sequence of pixels that is spatially consistent with the ground coverage. The radiometric calibration, attitude, and ephemeris data, associated with the band file, are provided in the payload correction and calibration data files. The MSCD file provides additional scan-related information for subsequent processing of the band file data to Level 1R/1G. The LPS provides one set of Level 0R data and a metadata file for each ETM+ data format: Format 1 and Format 2. The multiband scene browse data files are provided for Format 1 data only. These data formats are associated with Bands 1–6 and Bands 6–8 of the ETM+ instrument, respectively.

The following sections describe the Landsat 7 Level 0R data contents of LPS output files. Section 3 provides details on LPS file formats using the HDF file structures.

The LPS Format 1 output contains 10 Level 0R files plus from 1 to 35 full multiband scene browse files. Format 2 output contains 7–10 files depending on the size of Band 8 (1–3 segments).

2.1.1 Band Data File(s)

The LPS generates two sets of band files, one each for ETM+ Format 1 and ETM+ Format 2 Data. Bands 1–6 files are generated for the ETM+ Format 1 data. Bands 6–8 files are produced for the ETM+ Format 2 data. The Band 8 data, which could exceed the 2 GB restriction for HDF files, is contained in as many as three file segments. The number of Band 8 file segments produced by LPS depends on the size/duration of a Level 0R processed subinterval. The largest size Band 8 subinterval to be processed by LPS is expected to be approximately 5 GB (35 full scenes for a 14-minute subinterval/contact period).

Each band file contains detector (scan line) data produced by a single band during a Level 0R processed subinterval. All scan lines for all bands are constructed from the ETM+ data (minor frames) located between the time code and the End of Line Code minor frames. The scan line data is grouped by detectors such that, for a given major frame, detector 16 data is followed by detector 15 data, detector 15 data is followed by detector 14 data, and so on. Pixel order for the reverse scans is reversed before insertion into band files. This data is nominally aligned using fixed and predetermined integer-pixel values to provide alignment for band offset, odd/even detectors, and to accommodate for the forward-reverse scanning pattern of the ETM+ instrument. To avoid data duplication, ETM+ data quality and accounting information is provided in the MSCD file. This information includes counts of BCH corrected and uncorrected VCDUs,

as well as ETM+ major frame synchronization errors corresponding to band data lines in a scan. The LPS uses the HDF-EOS swath format for producing the band file(s).

2.1.2 Mirror Scan Correction Data File

LPS generates two MSCD files from each subinterval found in a contact period. One MSCD file is created for each ETM+ data format, Format 1 and Format 2, of a subinterval. Both the Format 1 and Format 2 MSCD files are expected to contain exactly the same MSCD unless one format contains more errors than the other. An MSCD file consists of data records for each major frame (ETM+ scan) received in a subinterval. Each MSCD record contains the SLD extracted from the two minor frames following the End of Line (EOL) Code in each major frame of a subinterval. The SLD includes the First Half Scan Error (FHS ERR), the Second Half Scan Error (SHS ERR), and the Scan Direction (SCN DIR) information for the previous ETM+ scan. The spacecraft time associated with the SLD source major frame is also appended with each MSCD record. Data quality information, such as counts of BCH corrected and uncorrected Virtual Channel Data Units (VCDUs) and the number of Channel Access Data Units (CADUs) detected with bit slip errors, is also provided on a major frame (ETM+ scan) basis for each MSCD record. The LPS uses the HDF-EOS Point structure format for generating the MSCD file.

2.1.3 Payload Correction Data File

The LPS generate a PCD file for each subinterval found in a contact period. Separate PCD files are created for the ETM+ Format 1 and Format 2 data in a subinterval. Both the Format 1 and Format 2 PCD files are expected to contain exactly the same PCD unless one format contains more errors than the other. A PCD file contains all PCD major frames received during a subinterval. Each PCD major frame is repeated at the PCD cycle rate. A PCD cycle consists of four unique major frames identified as PCD major frames (0), (1), (2), and (3). The PCD for each major frame is provided in Engineering Units (EUs), as appropriate. The PCD quality and accounting information, such as missing PCD words and PCD byte voting errors, is included in each PCD major frame. Partially received/assembled PCD minor and major frames are filled. Missing PCD major frames are also substituted with filled major frames. The LPS uses the HDF Vdata format for generating the PCD file.

2.1.4 Calibration Data File

The LPS generates two calibration data files, one each for ETM+ Format 1 and Format 2, for each subinterval. The Format 1 file contains all calibration data for Bands 1–6. The Format 2 file contains all calibration data for Bands 6–8.

The calibration data in each file is organized in a band sequential manner such that all calibration data for Band 1 is grouped first, followed by all calibration data for Band 2, and so on. The calibration data for each band consists of all band-deinterleaved detector data from all minor frames, starting immediately after the 2 SLD minor frames, of all ETM+ scans in a subinterval. Data from each detector in a scan is used to form a single calibration data line in a band group. For a given band, calibration data from all detectors is grouped in a scan incrementing/detector descending sequence (i.e., Scan

1/Detector 16, Scan 1/Detector 15, Scan 1/Detector 14 ... Scan 2/Detector 16, Scan 2/Detector 15, Scan 2/Detector 14, and so on) to form calibration data lines. Reverse scans (calibration data lines) are reversed during construction of a calibration file. All calibration data lines, forward and reverse, are aligned by applying the same integer-pixel shifts used in aligning the left hand side of the band data lines. The right hand side offsets, though, will differ from the band data lines in order to account for full bumper growth and the varying amount of data. The time of the ETM+ major frame corresponding to each calibration data line is also provided to support the swath structure (used as geolocation information).

Each calibration data line contains all band-detector data starting after the 2 Scan Line Data (SLD) minor frames in the current scan until the start of the Line Sync Code (LSC) for the next ETM+ scan. Thus, each scan/detector calibration data line contains all calibration and fill data found between the SLD and the next LSC, in subsequent byte locations. No calibration data (scan/detector words and/or minor frames) are dropped/omitted while constructing a calibration data line. Detailed information on the locations of calibration data bytes, located between the SLD and LSC in an ETM+ scan, is provided in the Landsat 7 Wideband Data DFCB. The ETM+ data quality and accounting information such as counts of BCH corrected and uncorrected VCDUs and ETM+ major frame synchronization errors, corresponding to each scan containing band and calibration data lines, is provided in the MSCD file.

The LPS provides the original location (minor frame counter value) of the first minor frame of the EOL code, for each ETM+ scan, in the MSCD file. The EOL original location can later be used as a reference to determine the actual location (distance from the first minor frame of the EOL code) of each calibration data sample (band-detector data) in an ETM+ scan. The LPS uses the HDF-EOS swath format for generating the calibration data file.

2.2 Metadata File

LPS generate a metadata file for each subinterval found in a contact period. The LPS generates a metadata file for each ETM+ data format, Format 1 and Format 2, of a subinterval. The Format 1 metadata file contains identification, quality, and accounting information on the Level 0R processed data for Bands 1–6. Similarly, the Format 2 metadata file contains identification, quality, and accounting information on the Level 0R processed data for Bands 6–8.

A metadata file contains information on the Level 0R processed data contained in a Format 1 or Format 2 subinterval: the names of all band data, calibration data, payload correction data, mirror scan correction data, and multiband scene browse files. The metadata also includes quality and accounting information on the return link wideband data used in generating the Level 0R file(s). In addition, metadata includes quality and accounting information on received and processed PCD and cloud cover assessment for the Worldwide Reference Scene (WRS) scenes, full or partial, contained in the associated subinterval. The LPS uses the ODL format for generating the metadata file.

2.3 Multiband scene browse Files

A multiband scene browse file is a reduced data volume file of the Level 0R band/image data which can be viewed on a scene basis to determine general ground area coverage and spatial relationships between ground area coverage and cloud coverage. The multiband scene browse data from three predetermined bands of the ETM+ Format 1 data are contained in a multiband scene browse file. The LPS generates a multiband scene browse file from each of the full resolution scenes (band-detector image data) contained in the three predetermined Level 0R band data files of a subinterval. The multiband scene browse file generated for Scan Line Corrector (SLC)-off data also provides a visual indication of approximately where the scan gaps fall relative to the scene content.

Partial scenes are identified similarly to full scenes. Partial scenes band data, if received, will be located at the start and end of a subinterval and provided as the first and the last browse scenes of the subinterval.

At present, a maximum of 35 full WRS scenes are expected in a 14-minute long subinterval. The LPS uses the HDF RIS24 format for generating the multiband scene browse file.

2.4 File Naming Convention

The L7 Project has agreed to the following convention for naming the LPS output files:

File Name: L7XsssfnYYDOYHHuuv.xxx where

Description	Remarks
L7 indicates the Landsat 7 mission	Fixed to "L7" for all files generated by LPS
X = 0 - 9	For LGS data, 1= XL (low frequency). 2 = XM (medium frequency). 3 = XH (high frequency). A value other than 1, 2, or 3 represents frequency unknown. For data received from other ground stations, the value in this position will be used as a unique identifier.
sss indicates data capture ground station, for example: sss = "EDC" at Sioux Falls, SD	A parameter retrieved from the Landsat 7 Raw Computer Compatible (RCC) filename. See the L7 to IGS ICD for the full set of IGS stations.
f indicates ETM+ data format: f = 1 for Format 1 data, f = 2 for Format 2 data	Identifies the ETM+ Format 1 or 2 data contained in this file. The ETM+ format information is taken from the "PCD/Status Data" field of the first error-free VCDU of the first major frame of the subinterval reported in this file.
n indicates LPS string number (1–9)	A predetermined number for each LPS string.
YYDOYHH: indicates the Landsat 7 contact period start date and time for this file, where YY = The last two digits of the year associated with a contact period, DOY = The Julian day (001 through 366) associated with the contact period, HH = The hour of the contact period within a 24-hour day (00–23)	The Julian date and Greenwich Mean Time (GMT) when the capture of a Landsat 7 contact period, associated with this subinterval, was started. This is retrieved from the Raw CC filename. For raw data tapes received from other Landsat 7 ground stations**, this time is expected to be available from the tapes. ** It is assumed that other Landsat 7 ground stations will comply with the Landsat 7 Raw CC data format specification for Landsat 7 raw wideband data tapes.
uu indicates a subinterval number within this contact period (01–99)	Generated by LPS during Level 0Ra processing.
v indicates file version number: v = 0 for the L0R processed data generated during the first processing run of a contact period. v = 1–9 for reprocessed Level 0R data generated during subsequent processing runs of the same contact period.	A reprocessing indicator used to distinguish the Level 0R files generated from a single contact period during multiple processing runs. An operator enters the reprocessing information during setup of a Level 0R processing operation.
xxx indicates an LPS File type: where xxx = Bis for band files where or B indicates a band file, i indicates ETM+ band IDs 1–8, s indicates a file segment number or types = 0 for single segment files for Bands 1–7, s = 1–3 for Band 8 file segments, or xxx = "MSD" for an MSCD file, or xxx = "PCD" for a PCD file, or xxx = "CAL" for a calibration file, or xxx = "MTA" for a metadata file, or xxx = "Rnn" for multiband scene browse files where nn = 01–99 indicates the WRS scene sequence number within the subinterval, identified in the metadata file.	No Level 0R files are generated when no subintervals can be found in a contact period (probably containing extremely noisy data). The LPS operations learn about this problem from the Level 0R quality and accounting report for the processed contact period. The LPS Band 8 Level 0R processed data is split into up to 2 Gigabytes (GB) segments to meet the HDF maximum file size limitation.

Table 2-1. File Naming Convention

Section 3 LPS Output File Formats(s)

3.1 LPS File Formats (HDF)

The HDF has been selected for exchanging data with external systems. HDF is also used for archiving the received data. The HDF supports standard data structures such as Vdata for storing various types of data. Special HDF structures and a support library have also been developed such as the HDF-EOS Swath for handling multiband remote sensing data collected by various satellites. Other industry standards have also been adopted such as the Consultative Committee on Space Data Systems (CCSDS) Object Description Language/Parameter Value Language (ODL) for handling English text like data. Table 3-1 identifies the HDF-EOS object structures used by LPS in generating the Level 0R output files, the metadata file, and multiband scene browse files. The LPS currently uses HDF version HDF4_1r1.

3.1.1 Band Data File Formats (HDF-EOS Swath)

3.1.1.1 Band Data File – Swath Format Overview

The LPS uses the HDF-EOS Swath structure for constructing band files. An LPS band file contains a single swath object. Each band data file contains a swath object consisting of a set of data fields, a set of geolocation fields, dimension information on each of the data and geolocation fields, and mapping of the geolocation fields to the data fields. Within the LPS band file swath context, the ETM+ instrument band-detector (scan line) data corresponds to the swath data field, and information about the band-detector data (e.g., spacecraft time, scan number, scan direction, and scan line number) correspond to the swath geolocation fields. The dimension information associates each geolocation field to data field (band array) dimensions (e.g., scanLineTrack). The WRS scene-related geolocation fields, consisting of calculated "actual" scene center and corner latitudes and longitudes, are associated with the band data dimensions using a list of indices (index dimension). For a full-length data scene, both the image (band) and ephemeris (PCD) data is expected to be available from the associated subinterval. Its "actual" scene center, expected in the proximity of the nominal WRS scene center, is computed from the actual PCD and indexed to actual data in the band file. For a partial scene with more than half a scene length data, the computed "actual" scene center is also expected to happen in the proximity of the nominal WRS scene center. The "actual" scene center for a greater than half a scene length partial scene may also be computed from the available actual PCD and indexed to actual data in the band file. For a partial scene with less than half a scene length data, the scene center may have to be computed from extrapolated ephemeris (no actual PCD may be available from the subinterval). The computed "imaginary" scene center for such a partial scene (less than half a scene) is still determined in the proximity of the nominal WRS scene center, but there will not be any actual band data in the subinterval band file to relate the scene center to. The computed "imaginary" scene center for a partial scene with less than half a scene length data is indexed to an "imaginary scan" (non-existent scan 0) in the band file. Figure 3-1 provides a structural overview of an HDF-EOS swath file/object for band data. Figure 3-2 provides an overview of the LPS band data organized under the HDF-

EOS Swath structure. Table 3-2 through Table 3-8 contain data, geolocation, and dimension details on the HDF-EOS Swath structure for constructing LPS band files.

LPS File	Applicable ETM+ Formats		File Contents (Note 1)	HDF Object Structure
Level 0R Files:				
Band 1 Image Data	1		Binary	Swath
Band 2 Image Data	1		Binary	"
Band 3 Image Data	1		Binary	"
Band 4 Image Data	1		Binary	"
Band 5 Image Data	1		Binary	"
Band 6 Image Data	1		Binary	"
Band 6 Image Data		2	Binary	Swath
Band 7 Image Data		2	Binary	"
Band 8 Image Data (1–3 segments, 1 file per segment, up to 2 GB each)		2	Binary	"
Mirror Scan Correction Data (MSCD)	1	2	Mixed	Point
Payload Correction Data	1	2	Mixed	Vdata
Calibration Data (Bands 1–6)	1		Binary	Swath
Calibration Data (Bands 6–8)		2	Binary	Swath
Level 0R Related Files:				
Metadata	1	2	ASCII Text	ODL
- Subinterval Level Metadata- WRS Scene Level Metadata- ACCA Results- Level 0R Q&A	1111	222		
Multiband Scene Browse (one scene per file)	1		Binary	RIS24

Note 1: Applies to data and/or ancillary information formats only.

Table 3-1. LPS Output Files - HDF Object Structures

An LPS band swath object consists of (band) swath data fields and (band) swath geolocation fields. Data fields in a band swath contain a contiguous set of scan data lines from a selected ETM+ band. Geolocation fields provide identification and data quality and accounting information for each scan data line in the band swath. A dimension map provides the linkage between geolocation fields and their associated scan data lines. Geolocation values for each scan data line in a band swath are provided. An index map provides selected mapping between geolocation fields and scan data lines. This mapping is used to provide scene center and corner reference points (scan data line locations) in the band data swath. See the Remarks section of Table 3-8 for mapping information, which is specific to band 8.

In the case of band 8 data where the subinterval data is written to multiple segment files, scenes are defined in the swaths of each segment file such that they are not

broken across segments. In other words, the data for any given scene is extractable from a single band 8-segment file. Because in the course of band file generation, the image data is written to the files before the scenes are defined, it is necessary to write the equivalent of a full scene's worth of data (i.e., 375 scans) to both the end of the current segment file and concurrently to the beginning of the next segment file. This insures that when a scene happens to fall near a segment boundary the data is there to map it to the next segment if there is not room for it in the preceding segment. This results in 375 scans being duplicated at the end of the current segment and at the beginning of the next segment.

3.1.1.2 Band Data File Volume(s)

The following assumptions and band data volume information are used in defining HDF-EOS swaths and attributes for LPS band files:

1. ETM+ scans per scene:

   - Nominal: 335 (received WRS scene without scans overlap)
   - Maximum: 375 (distribution WRS scene with scans overlap)

2. Scan data lines (nominal, without scans overlap) per scene:

   - Bands 1–5 and 7: 335 x 16 = 5,360
   - Band 6: 335 x 8 = 2,680
   - Band 8: 335 x 32 = 10,720

3. Scan data lines (maximum, with scans overlap) per scene:

   - Bands 1–5 and 7: 375 x 16 = 6,000
   - Band 6: 375 x 8 = 3,000
   - Band 8: 375 x 32 = 12,000

4. Subinterval duration: ~14 minutes (maximum)
(longest possible contact period duration)

5. Scene duration: ~ 24 seconds

6. Number of scenes per subinterval: ~ 35 (maximum)
(longest possible contact period with a single subinterval)

7. ETM+ scans per subinterval:
   Nominal: 335 x 35 = 11,725

8. Scan data lines (maximum) per subinterval (scans do not overlap):

   - Bands 1–5 and 7: 5,360 x 35 = 187,600
   - Band 6: 2,680 x 35 = 93,800

- Band 8: 10,720 x 35 = 375,200
- Band 8: 5034 scans x 32 detectors = 161,088 (maximum possible in a 2 GB file segment) [2 GB - 20 MB swath overhead = 2,126,512,128 bytes. 32 x 13,200 = 422,400 bytes per scan. This gives 5034 maximum scans in a segment.]

9. Active scan data line lengths (nominal):

- Bands 1–5 and 7: 6313 Bytes [6320-7 for timecode and line sync code]
- Band 6: 6320/2 = 3160 Bytes [no timecode and line sync code]
- Band 8: 6313 x 2: 12,626 Bytes

10. LHS margins: alignment + bumper wear + extra/error

- Band 1: 40 Bytes
- Band 2: 65 Bytes
- Band 3: 90 Bytes
- Band 4: 115 Bytes
- Band 7: 160 Bytes
- Band 5: 186 Bytes
- Band 6: 110 Bytes
- Band 8: 30 Bytes

11. RHS margins: alignment space + bumper wear + extra/error

- Bands 1-5, 7: RHS = 6600 - LHS – 6313
- Band 6: RHS = 3300 - LHS - 3160
- Band 8: RHS = 13200 - LHS - 12626
- Band 1: 247 Bytes
- Band 2: 222 Bytes
- Band 3: 197 Bytes
- Band 4: 172 Bytes
- Band 7: 127 Bytes
- Band 5: 101 Bytes
- Band 6: 30 Bytes
- Band 8: 544 Bytes

12. Band data line lengths (based on Band 1 margins):
(nominal length + LHS margins + RHS margin)

- Bands 1–5 and 7: 6,313 + 40 + 247 = 6,600 Bytes
- Band 6: 3,160 + 20 + 120 = 3,300 Bytes (or 6,600/2 = 3,300)
- Band 8: 12,626 + 80 + 494 = 13,200 Bytes (or 6,600 x 2 = 13,200)

13. Subinterval band data file volumes (maximum):

- Bands 1–5 and 7: 187,600 x 6,600 = ~ 1.238 GB
- Band 6: 93,800 x 3,300 = ~0.310 GB
- Band 8: 375,200 x 13,200 = ~4.953 GB (all segments)
- HDF File Size Limit = 2 GB (maximum)
- Band 8 Segments: 4.953 / 2 = ~2.476 (or 3 maximum)
- Band 8 Segment Size in LPS = up to 2 GB

3.1.1.3 Band Fill Data

The LPS uses two values to fill VCDU minor frames to distinguish missing/bad band data from good data. The two values are placed as follows:

Odd detectors: fill with a pattern of 0s (00000000)

Even detectors: fill with a pattern of 255s (11111111)

This will be done on a minor frame basis - that is, if data is missing from part of a minor frame the whole minor frame will be filled. This fill pattern can be adjusted through the user interface. However, the fill pattern will not be changed without prior L7 DCCB approval. Note that scan alignment fill data at the beginning and end of a scan will be all 0s. This is margin data and other data used for the integer-pixel alignment.

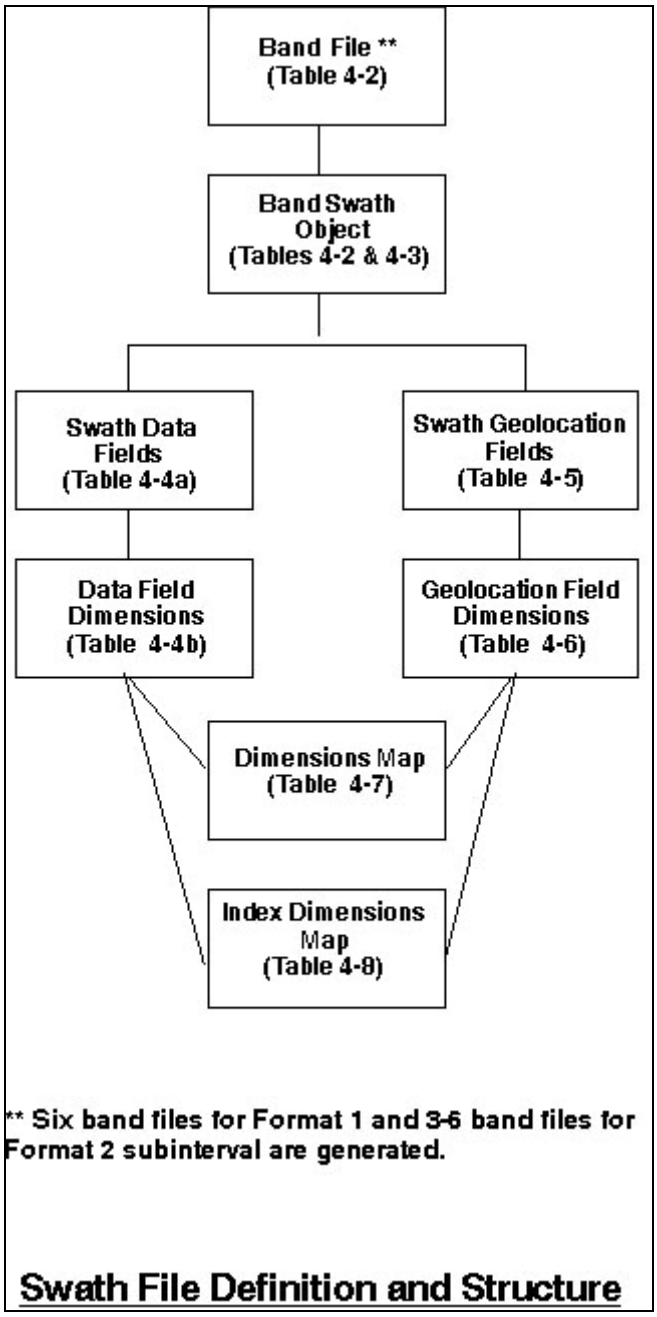

Figure 3-1. Band Data File – HDF-EOS Swath Structure

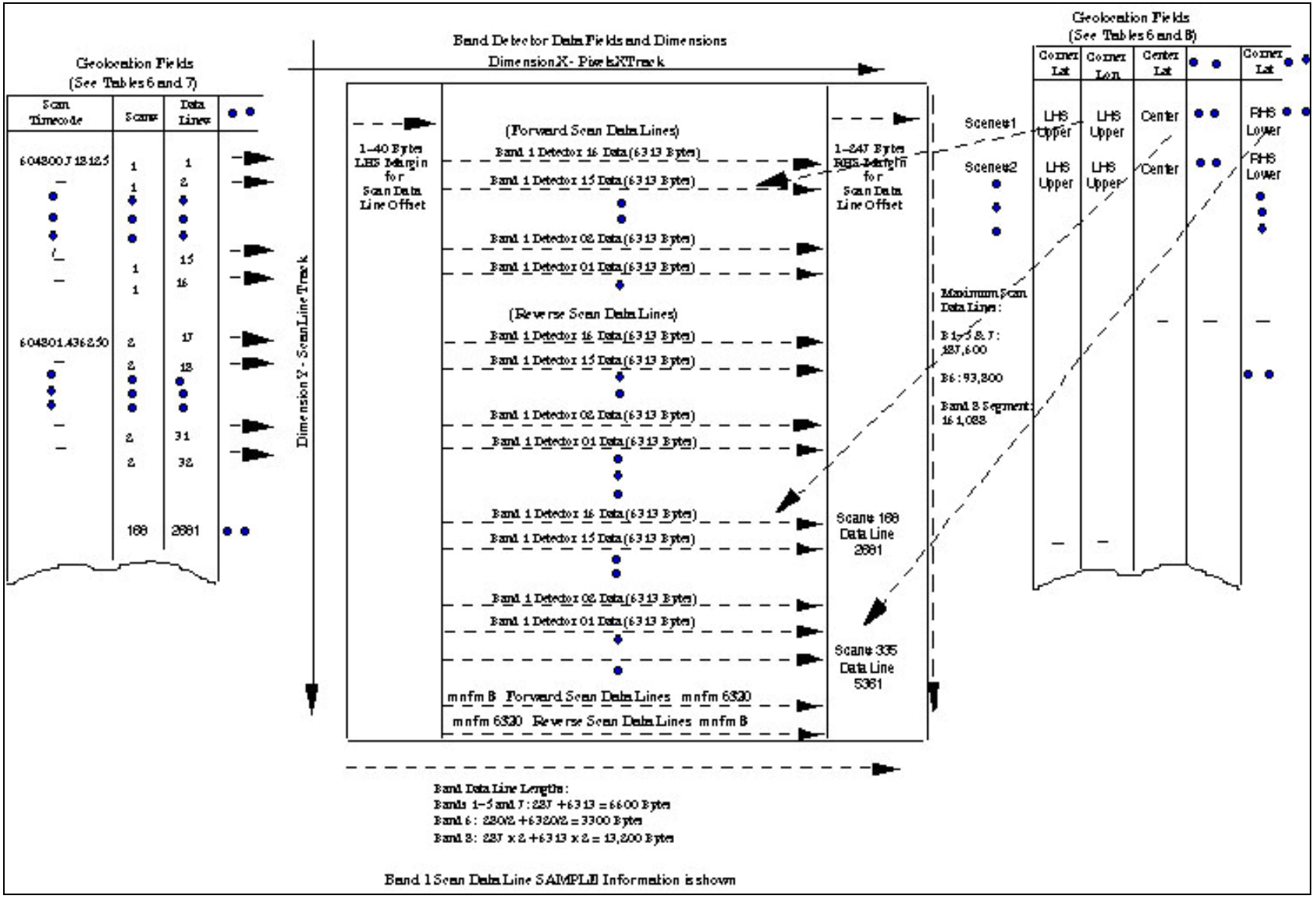

Figure 3-2. Band Data File - ECS-HDF Swath Overview

Swath Definition Parameter	Number Type and (Size)	Value, Format, Range and Unit	Parameter Description / Remarks
file_name	char8 (22)	= L7XsssfnYYDOYHHuuv.xxx where xxx indicates the band file identification details.	See Section 2.4 for complete details on the LPS file naming convention.
swath_name	char8(6)	= Band_Swath_Bis where "Band_Swath_" identifies a L7 band data HDF-EOS swath object. One band swath object is produced for each ETM+ band, except Band 8. Up to three band swath objects, LPS may produce one each for Band 8 file segment and up to 2 GB in size. Each band swath object is stored in a separate band swath file. Bis identifies ETM+ Format 1 and Format 2 band (image) data source bands as follows: Bi = B1–B8 for ETM+ Bands 1–8 s = 0 for single segment swaths for Bands 1–6 s = 1–3 for Band 8 segments (swaths).	Defined in accordance the xxx = "Bis" subset in the LPS file naming convention. See Section 2.4 for deriving the band file identification (Bis) details from the band data. Format 1 band data swath names: = Band_Swath_B10 = Band_Swath_B20 = Band_Swath_B30 = Band_Swath_B40 = Band_Swath_B50 = Band_Swath_B60 Format 2 band data swath names: = Band_Swath_B60 = Band_Swath_B70 = Band_Swath_B81 = Band_Swath_B82 = Band_Swath_B83 One band swath file contains one swath object.

Table 3-2. Band Data File - Swath Object Definition Parameters

Attribute Name	Number Type (ntype)	Count	Attribute Values	Remarks
detector_count	int8	1	= 16 for Bands 1–5 and 7, = 8 for Band 6, and = 32 for Band 8	The detector_count value selected for a band is fixed for the whole band file.
scene_count	Int8	1	= 1–99 (full and/or partial) WRS scenes determined by LPS during Level 0Ra processing.	A maximum of 35 full scenes are expected in a 14-minute subinterval.

Table 3-3. Band Data File - Swath Object Attributes

Data Field Name	Type	Count	Values	Remarks
band_detector_data	uint8	= 6,600 for Bands 1-5 and 7 = 3,300 for Band 6 = 13,200 for band 8 (segments)	= 0 – 255 (grayscale/ pixel data)	Band data are extracted, in minor frame order, from a single detector to form a scan line. All detectors of a band are used, in sequential order, to form all scan data line of a band in a scan. Table 3-3 provides the detector count for each ETM+ band. Section 3.1.2 lists the total number of scans and scan data lines contained in each band swath object. Band 8 is split into 1-3 segments (files). Each Band 8 segment file contains swath object for a Band 8 segment.

Table 3-4. Band Data File - HDF Swath Data Field

Data Field Name	Number Type	Cross-Track Dimension Name and Size	Track Dimension Name and Size	Merge Code
band_detector_data	uint8	Name: PixelsXTrackSize: = 6,600 for Bands 1–5 and 7 = 3,300 for Band 6 = 13,200 for each Band 8 segment	Name: ScanLine Track Size: 1–11,725 scans * x detector_count Or = 1–187,600 for Bands 1–5 & 7 = 1–93,800 for Band 6 = 1–375,200 for Band 8 (1–161,088 scan lines per Band 8 file segment) *Without scene overlaps	=HDFE_NOMERGE (0) (no merge) There is only one band_detector_data field in a single swath in a subinterval band file.

Table 3-5. Band Data File - HDF Swath Data Field Dimensions

Geolocation Field Name	Number Type	Count	Value	Remarks
scan_timecode	char8	25	Scan line time of the form 'YYYY:ddd:hh:mm:ss.tttttt' Where YYYY: Four-digit Julian year ddd: Day (01 through 366**) hh: hours (00 through 23) mm: minutes (00 through 59) ss: seconds (00 through 59) tttttt: fractional seconds (0–9999375, where the clock cycle is 1/16 millisecond) ** For cases when active imaging occurs at the end of a leap year.	The ETM+ scan start time extracted from the timecode minor frames of the ETM+ major frame data reported in this record. A computed scan start time is provided if a valid time is not available from the ETM+ time code minor frames.
Time	float64	1	The ETM+ scan time in seconds since midnight on January 1, 1993, rounded to 7 decimal places.	The scan time is obtained by converting the scan_timecode (see above) to seconds.
scan_no	uint16	1	scan_no = 1–11,725 The maximum scan count is based on a subinterval duration of 14 minutes for 35 scenes, each consisting of 335 scans. (See Section 3.1.1.2) Note: The Band 8 scan data line count is not reset between segments (1–3). Duplicate data lines between segments have the same value for this field.	Provides a sequence counter for ETM+ scans (major frames) contained in a subinterval. The ETM+ scan counter is incremented by one for each new scan, real or flywheeled, added to the subinterval file.
scan_data_line_no	uint32	1	scan_data_line_no = SSSSSS where SSSSSS = 1–187,600 for Bands 1–5 and 7 = 1–93,800 for Band 6 = 1–375,200 for Band 8	The scan line counter is incremented for each Band-Detector data line added to the subinterval band file. There are 16 scan data lines each for Bands 1–5 and 7, 8 for Band 6, and 32 for Band 8

			Note: The Band 8 scan data line count is not reset between segments (1–3). Duplicate data lines between segments have the same value for this field.	in each ETM+ scan. The maximum line counts are shown for a 14-minute subinterval (35 scenes).
scan_dir	char8	1	Scan direction character 'F' = Forward scan 'R' = Reverse scan 'U' = Unknown scan direction	The current ETM+ scan direction information obtained directly from the word 5, bit 1 of the PCD/Status data for the current scan. A valid ETM+ major frame has no errors. The default Forward direction will be used as the scan direction for the scan for the purpose of placing the data if the direction is unknown.
detector_id	uint8	1	where the detector_id is in the range: = 1–16 for Bands 1–5 and 7 = 1–8 detectors for Band 6 = 1–32 for Band 8	Each scan line in a band file consists of pixel data (bytes) from a single detector of a single band (see Figure 3-2). Each detector, chosen in a descending ID order, is used once during each scan for generating a scan line.
scan_data_line_offset_rhs	int16	1	= 0–287 bytes for Bands 1–5 and 7 = 0–140 bytes for Band 6 (Format 1) and 6H (Format 2) = 0–574 bytes for Band 8 The scan line data may be shifted to right in the band data buffer after an integer-pixel alignment. The maximum value in the above ranges represents the sum of the RHS plus LHS offsets before bumper wear.	The scan line data in each record of the band file is initially written with a predetermined size of byte offset on the left and right of the designated scan line data area with a pattern of zeros. During integer-pixel alignment, these offsets provide moving in space (to avoid data loss) for the right-shifted band-detector data. After an integer-pixel alignment, this field indicates the resulting start and stop bytes/pixel

				positions for scan lines. This offset also accommodates scan line length growths due to ETM+ scanner bumper wear. (See Figure 3-2)
scan_data_line_offset_lhs	int16	1	= 0–287 bytes for Bands 1–5 and 7 = 0–140 for Band 6 = 0–574 for Band 8 The scan line data may be shifted to left in the band data buffer after an integer-pixel alignment.	Note: The left-hand-side offset is not as significant as the right-hand-side margin. It can accommodate scan line length growths due to ETM+ scanner bumper wear. (See Figure 3-2) This value is dependent on values in the calibration parameter file.
scene_center_latitude	float32	1	= -90.0 to +90.0 degrees A positive (+) value indicates a North latitude. A negative (-) value indicates a South latitude.	WRS Scene Center Latitude - LPS calculated "actual" center. This is needed for internal LPS processing. The computed "actual" scene centers for full and greater than half a scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the band file. The computed "actual" scene centers for smaller than half a scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the band file.
scene_center_longitude	float32	1	= -180.0 to +180.0 degrees A positive value (+) indicates an East longitude. A negative (-) value indicates a West longitude.	WRS Scene Center Longitude at LPS calculated "true center". This is needed for internal LPS processing. Latitude and longitude values are calculated for WRS scenes that contain 375 scans (335 + 40 overlap scans).

				The computed "actual" scene centers for full and greater than half a scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the band file. The computed "actual" scene centers for smaller than half a scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the band file.
Latitude	float32 array ul ur ll lr	2	= -90.0 to +90.0 degrees for each value of the array. A positive (+) value defines a latitude to the North. A negative (-) value defines a latitude to the South.	The Latitude geolocation field is made up of WRS scene upper-left (ul), upper-right (ur), lower-left (ll), and lower-right (lr) corner "actual" latitudes for a full or a partial scene. It is made up of a 2x2 array of values for each scene.
Longitude	float32 array ul ur ll lr	2	= -180.0 to +180.0 degrees for each value of the array. A positive value (+) defines a longitude to the East. A negative (-) value defines a longitude to the West.	The Longitude geolocation field is made up of WRS scene upper-left (ul), upper-right (ur), lower-left (ll), and , lower-right (lr) corner "actual" longitudes for a full or a partial scene. It is made up of a 2x2 array of values for each scene.

Table 3-6. HDF Swath Geolocation Fields

Geolocation Field Name	Number Type	Track Dimension Name and Size	Merge Code
scan_timecode	char8	Name: TimecodeTrack,String Size: 1–11,725	= HDFE_AUTOMERGE (1) (OK to merge fields with shared dimensions and/or data type)
Time	float64	Name: TimeTrack Size: 1–11,725	= HDFE_AUTOMERGE (1)(merge)
scan_no	uint16	Name: ScanTrack Size: 1–11,725	= HDFE_AUTOMERGE (1)(merge)
scan_data_line_no	uint32	Name: ScanLineNoTrack Size: 1–11,725 x detector_count for selected band (See Table 3-3)	= HDFE_AUTOMERGE (1)(merge)
scan_dir	char8	Name: ScanDirTrack Size: 1–11,725	= HDFE_AUTOMERGE (1)(merge)
detector_id	uint8	Name: DetectorIdTrack Size: 1–11,725 x detector_count for selected band (See Table 3-3)	= HDFE_AUTOMERGE (1)(merge)
scan_data_line_ offset_rhs	int16	Name: RhsOffsetTrack Size: 1–11,725 x detector_count for selected band (See Table 3-3)	= HDFE_AUTOMERGE (1)(merge)
scan_data_line_ offset_lhs	int16	Name: LhsOffsetTrackSize: 1–11,725 x detector_count for selected band (See Table 3-3)	= HDFE_AUTOMERGE (1)(merge)
scene_center_ latitude	float32	Name: CenterTrack Size: 1–scene_count (See Table 3-3)	= HDFE_AUTOMERGE (1)(merge)
scene_center_ longitude	float32	Name: CenterTrack Size: 1–scene_count	= HDFE_AUTOMERGE (1)(merge)
Geolocation Field Name	Number Type	Track Dimension Name and Size	Merge Code
Latitude	float32 array (2x2 per scene)	Name: GeoTrack, GeoXtrack Size: 2–2*scene_count, 2	= HDFE_AUTOMERGE (1)(merge)
Longitude	float32 array (2x2 per scene)	Name: GeoTrack, GeoXtrack Size: 2–2*scene_count, 2	= HDFE_AUTOMERGE (1)(merge)

Table 3-7. Band Data File - HDF Swath Geolocation Field Dimensions

Note: The terms "scan" and "Scan (Data) Line" provide two different views of the ETM+ data. A Scan (Data) Line is a subgroup of an ETM+ scan. These terms are defined as follows:

Scan: A scan results from a cross-track motion of the ETM+ instrument and consists of detector-sensed data from all bands. ETM+ Bands 1 through 5 and 7 produce 16 detector data lines each during each scan. Bands 6 and 8 produce 8 and 32 detector data lines, respectively, during each ETM+ scan.

Scan (Data) Line: A scan line is an image data line, which is produced from a single detector of a band during a scan.

The geolocation fields (e.g. scan_no, Time and scan_data_line_no) associated with scan and scan data line are expected to lie along the same dimension (ScanLineTrack), except that they may occur at different increments and/or offsets.

Geolocation Dimension Name	**Data Dimension Name**	**Offset**	**Increment**
TimecodeTrack	ScanLineTrack	= 0 The timecode starts with the first scan line.	= detector_count The timecode repeats at detector count intervals.
TimeTrack	ScanLineTrack	= 0	= detector_count
ScanTrack	ScanLineTrack	= 0	= detector_count
ScanLineNoTrack	ScanLineTrack	= 0	= 1
ScanDirTrack	ScanLineTrack	= 0	= detector_count
DetectorIdTrack	ScanLineTrack	= 0 The detector ID starts with the first scan line.	= 1 The detector ID repeats on a scan line basis.
LhsOffsetTrack	ScanLineTrack	= 0 The left-hand-side offset starts with the first scan line.	= 1 A left-hand-side offset is present for each scan line.
RhsOffsetTrack	ScanLineTrack	= 0	= 1
String [Size 25]	N/A	N/A	N/A

Table 3-8. Band Data File - HDF Swath Dimension Map

Geolocation Dimension Name	Data Dimension Name	Index (array size)(Indices of Data Dimension)	Remarks
CenterTrack	ScanLineTrack	CenterScanLine (scene_count) (See Table 3-3)	Each scene center is associated with a unique/single scan line in a band file except for partial scenes. Centers for partial scenes may lie outside the sub-interval. In this case the scene center is not associated with a scan line. In the case of band 8, the values in this array shall contain information only for those scenes that are defined to be in the current segment and the scan line values shall be relative to the beginning of the subinterval (i.e., the beginning of the first segment file).
GeoTrack	ScanLineTrack	GeoIndex (2*scene_count)	Each corner (for both longitude and latitude) is associated with a specific scan line in the band file to distinguish their upper and lower corner positions. Note that data index mapping counts start at 0. In the case of band 8, the values in this array shall contain information only for those scenes that are defined to be in the current segment and the scan line values shall be relative to the beginning of the swath in the current segment.
GeoXtrack	PixelsXTrack	2	Used to index from left to right in Longitude and Latitude geolocation fields.
UpperTrack	ScanLineTrack	UpperScanLine (scene_count)	Each corner is associated with a specific scan line in the band file to identify its upper and lower corner positions. This is needed for internal LPS processing. In the case of band 8, the values in this array shall contain information only for those scenes that are defined to be in the current segment and the scan line values shall be relative to the beginning of the subinterval (i.e., the beginning of the first segment file).
LowerTrack	ScanLine Track	LowerScanLine	(See UpperTrack)

Table 3-9. Band Data File - HDF Swath Index Dimension Map

3.1.2 MSCD File Format (HDF-EOS Point)

3.1.2.1 MSCD File Description

The LPS generates an MSCD file for each ETM+ format: Format 1 and Format 2. The LPS uses the HDF-EOS Point structure for generating an MSCD file. Table 3-9 defines the HDF-EOS Point structure for the LPS MSCD file. The MSCD file name follows the file naming convention of Section 2.4. It is not included in the MSCD file itself.

The MSCD file is organized by ETM+ scans. The spacecraft time associated with each ETM+ scan is provided in seconds since January 1, 1993. This spacecraft time is also provided in the Julian day of year and time format.

The MSCD file format is designed to be neutral to ETM+ Format 1 or Format 2 data. The LPS should produce mirror copies of the MSCD file for both formats if they are received with the same MSCD minor frame words with same errors.

3.1.2.2 MSCD Fill Values

Under noisy data input and poor CADU/VCDU and ETM+ data synchronization conditions, the values for most MSCD fields are expected to be generated through flywheel and/or computation processing. MSCD fields "scan_no" and "Time" are examples of such fields. They can always be determined even if a major frame is entirely filled. However, some MSCD fields will require the use of a fill pattern and/or flags to indicate that correct values could not be determined due to an entirely filled ETM+ major frame. Such MSCD fields include: "gain_status", "mux_assembly_id" and "cal_shutter_status" fields. The fill and/or flag values for these fields are included with their specifications in the MSCD file format (Table 3-9). Other fields will be filled with a value of 0. These are the "eol_location," "fhs_vote," "fhs_err," "shs_vote," "shs_err," "cadu_sync," "scan_sync," "cadus/vcdus_received," "fly_wheel_cadus," "bit_slip_cadus," "r-s_err_cadus," "bch_corrected_vcdus," "bch_uncorrected_vcdus, " and "minf_filled" fields.

HDF-EOS Point Name: LPS_MSCD	
Point Level: MSCD	
Bytes Per Logical Record: 89	(Excluding HDF overhead) Maximum File Size = 0.99 MB for a 14-minute subinterval (11,728 major frames)
Number of Records: One record per ETM+ scan (major frame)	

Field Name	Number Type	Order	Description	Remarks
scan_no	uint16	1	Subinterval scan counter =1 - 11725 where, the maximum scan count of 11,725 is based on a maximum subinterval duration of 14 minutes for 35 scenes, each consisting of 335 scans;	Provides a sequence counter for the ETM+ scans (major frames) contained in a subinterval. The ETM+ scan counter is incremented by one for each new scan, real or flywheeled, added to the subinterval file. An LPS-produced subinterval can contain data for a partial WRS scene (less than 335 scans).
Time	float64	1	The ETM+ scan time in seconds since midnight on January 1, 1993, rounded to 7 decimal places.	The scan time is obtained by converting the scan_timecode (see below) to seconds.
scan_ timecode	char8	25	Scan line time of the form 'YYYY:ddd:hh:mm:ss.ttttttt' Where YYYY: four-digit Julian year ddd: day (01– 366**) hh: hours (00–23) mm: minutes (00–59) ss: seconds (00–59) ttttttt: fractional seconds (0–9999375, where the clock cycle is 1/16 millisecond) ** For cases when active imaging occurs at the end of a leap year.	The ETM+ scan start time extracted from the timecode minor frames of the ETM+ major frame data reported in this record. A computed scan start time is provided if a valid time is not available from the ETM+ time code minor frames. This time is expressed in Greenwich Mean Time (GMT) standard.
timecode_ flag	uint8	1	Valid timecode flag: 0 = valid timecode 1 = computed timecode	
eol_flag	uint8	1	Flag for valid end of line	The presence of an EOL

			(EOL) pattern code: 0 = valid pattern in expected location (minor frame location) 1 = missing EOL - the EOL pattern is not found at all 2 = valid pattern found inside user specified range but outside nominal range	code is needed by LPS to start calibration data extraction. If there is a missing EOL the nominal scan line length will be assumed. This way the pixel data may be salvaged, but the flag is needed to warn users that it may be suspect. Calibration data, though, would need to be filled since there is no way of knowing just where that started. A user specified parameter gives the bilateral search zone around the nominal location for the EOL marker. The nominal range for the EOL marker is given in the eol_location field description.
eol_location	uint16	1	Minor frame location (number in the range:6,318–6,323) The minor frame location (number) within a major frame that contains the first word of the ETM+ End of Line (EOL) code. The eol_flag reports eol_location errors.	The EOL is expected to occur within the vicinity of minor frame number 6,320 in each ETM+ major frame. The EOL code consists of two adjacent minor frames. The EOL indicates an end of the active scan period and start of a calibration data period past the scan line data (SLD) words. If eol_flag =1, LPS will supply the nominal location for eol_location.
scan_dir_ vote	uint8	1	Scan direction majority vote quality 0 = all bits in all scan direction word groups are equal 1 = at least one bit in the scan direction word groups is not equal to the other bits 2 = the scan direction is not found for a missing and/or an entirely filled scan. It is interpolated from the previous scan.	A majority vote quality of 1 may indicate an error with the received and/or decoded scan direction value (back-to-back forward or reverse scans). See note after table.
scan_dir	char8	1	Scan direction character 'F' = Forward scan 'R' = Reverse scan 'U' = Unknown scan	The ETM+ scan direction information is interpolated from the Scan Line Data (SLD) minor frames of the

			direction	ETM+ major frame. The scan direction value reported here is for the PREVIOUS scan (ETM+ major frame). The default Forward direction will be used as scan direction for the purpose of placing the data if the direction is unknown.
fhs_vote	uint8	1	FHS error majority vote quality0 = all bits in each FHS Error word group are equal1 = at least one bit in at least one FHS Error word group is not equal to the other bits in the group	A value of '1' indicates that the received/decoded fhs_err value is probably erroneous.
fhs_err	int16	1	First half scan error count:- 2048 to + 2047 This is a 12-bit number provided in an int16 field using 2's complement notation. See the Landsat 7 Wideband Data DFCB for additional details.	The first half scan error (FHS ERR) is extracted from the Scan Line Data (SLD) minor frames of the ETM+ major frame. The FHS ERR value reported here is for the PREVIOUS scan (ETM+ major frame).
shs_vote	uint8	1	SHS error majority vote quality 0 = all bits in each SHS Error word group are equal 1 = at least one bit in at least one SHS Error word group is not equal to the other bits in the group	A value of "1" indicates that the received/decoded shs_err value is probably in error.
shs_err	int16	1	Second half scan error count :- 2048 to + 2047 This is a 12-bit number provided in an int16 field using 2's complement notation. See the Landsat 7 Wideband Data DFCB for additional details.	The second half scan error (SHS ERR) is interpolated from the Scan Line Data (SLD) field of the ETM+ major frame. The SHS ERR value reported here is for the PREVIOUS scan (ETM+ major frame).
gain_status	char8	9	= ggggggggg where g indicates band positions 123456678 for the Format 1 and Format 2 band gain	For each band, the gain status is defined by the gain state value contained in the "PCD/Status Data" field of

			status. Band position subsets 123456 and 678 are associated with Format 1 and Format 2 bands, respectively. g = L in a band position indicates a low gain, g = H in a band position indicates a high gain, g = Ns in all band positions indicate that gain values could not be found due to an entirely filled major frame.	the first error-free VCDU of the ETM+ major frame. The gain_status values for all ETM+ bands are provided in both Format 1 and Format 2 MSCD files.
gain_change	char8	9	= ggggggggg where g indicates band positions 123456678 for the Format 1 and Format 2 bands gain changes. Band position subsets 123456 and 678 are associated with Format 1 and Format 2 band gain changes, respectively. g = 0 in a band position indicates no gain change, i.e., the gain_status of the previous scan is equal to the gain_status of this scan OR no band gains changed due to an entirely filled major frame. g = + in a band position indicates a gain change from low to high g = - in a band position indicates a gain change from high to low	The gain_change values in the first scan should be set to all "0s" because the previous scan required for the band gain change comparisons does not exist. The gain_change values for all ETM+ bands are provided in both Format 1 and Format 2 MSCD files.
mux_ assembly_id	uint8	1	= 0–7 for Landsat 7 multiplexer assemblies 0–7 OR = 9 to indicate that the mux_assembly_id value could not be extracted from an entirely filled major frame.	Identifies the Landsat 7 spacecraft on-board multiplexer used in the ETM+ data flow for this major frame. The multiplexer status is obtained from the first error-free CADU/VCDU used in the construction of this major frame.
cal_shutter_ status	uint8	1	0 = CAL shutter, 1 = Backup shutter OR	Identifies the Landsat 7 spacecraft on-board CAL shutter status during the

			= 9 to indicate that the cal_shutter_status value could not be extracted from an entirely filled major frame.	ETM+ data flow for this major frame. The CAL shutter status is obtained from the first error-free CADU/VCDU used in the construction of this major frame.
cadu_sync	uint8	1	Flag to indicate loss of CADU sync anywhere within the scan: 0 = no loss 1 = sync loss	A sync loss condition indicates potential loss of minor frame data requiring LPS to use fill data in completing a major frame (ETM + Scan).
scan_sync	uint8	1	Flag for valid sync for current major frame: 0 = valid sync 1 = flywheeled sync	Valid sync: The line sync code was correctly found and decoded as specified in the Landsat 7 Wideband Data DFCB. Flywheeled sync: The sync in the current scan is forced "True" because line sync code minor frame could not be found and/or correctly decoded as specified in the Landsat 7 Wideband Data DFCB. The presence of the Line Sync Code is "deduced" from correctly finding/decoding the Time Code minor frames of the current ETM+ major frame or the next scan sync.
minf_faults	char8	1	An index (hexadecimal 0 through D) representing the number of minor frame faults (m) in the range: '0' = no faulty minor frames' 1' = 1 ≤ m ≤2 '2' = 3≤ m ≤ 4 '3' = 5≤ m ≤ 8 '4' = 9 ≤ m ≤ 16 '5' = 17 ≤ m ≤ 32 '6' = 33 ≤ m ≤ 64 ‘7' = 65 ≤ m ≤ 128 '8' = 129 ≤ m ≤ 256' ‘9' = 257 ≤ m ≤ 512 'A' = 513 ≤ m≤ 1024 'B' = 1025 ≤ m ≤ 2048 'C' = 2049 ≤ m ≤ 4096 'D' = 4097 ≤ m ≤ NNNN 'E' = Not Applicable	LPS computes this quality index on a major frame basis. This index provides a quick-look assessment on the number of faulty minor frames contained in a major frame. Faulty minor frames contain fill data or are extracted from VCDUs containing uncorrected BCH errors. Lower quality indices indicate better quality major frames. Without bumper wear, there are a nominal 7,473* minor frames in an ETM+ major frame.** Accounting for 17*** minor frames of

			'F' = Not Applicable NNNN is an LPS operator-selectable parameter for the maximum number of minor frames possible in an ETM+ major frame.	bumper wear on each end of the scanner, there could be a maximum of 7,507 minor frames in an ETM+ major frame. Source: Landsat 7 Wideband Data DFCB Table 7 ** During testing at ambient temperature and pressure the number of minor frames increases to 7,491 in a major frame. *** LPS design assumption.
cadus/vcdus _received	uint16	1	= 0–650 (decimal) Approximately 643 VCDUs are required to build one ETM+ major frame (consisting of approximately 7,473 minor frames).	The total number of unfilled (good) VCDUs used in the construction of this ETM+ major frame.
fly_wheel_ cadus	uint16	1	= 0–650	The total number of flywheel CADUs/VCDUs in this ETM+ major frame.
bit_slip_ cadus	uint16	1	= 0–650	The total number of CADUs/VCDUs detected with bit slip errors in this ETM+ major frame.
r-s_err_ vcdus	uint16	1	= 0–650	The total number of VCDUs with uncorrected Reed-Solomon errors used in the construction of this ETM+ major frame.
bch_ corrected_ vcdus	uint16	1	= 0–650	The total number of VCDUs, containing corrected BCH errors, in this major frame.
bch_ uncorrected_ vcdus	uint16	1	= 0–650	The total number of VCDUs, containing uncorrected BCH errors, in this major frame.
filled_scan_ flag	uint8	1	0 = no fill data used in this scan 1 = entirely filled scan 2 = partially filled scan	This flag indicates if any predetermined fill data was used in the construction of this ETM+ scan (major frame). There are a nominal 7,473 minor frames in a scan.
minf_filled	uint16	1	0–7500	The total number of filled

				minor frames in this ETM+ major frame. There are a nominal of 7,473 minor frames in a scan.
minf_ received	float32	1	number of minor frames received in the major frame including fraction contained in last minor frame	There are a nominal 7,473 minor frames in a scan with a final minor frame typically being some number less than the nominal 85 bytes.

Table 3-10. MSCD File - HDF Vdata Definition and Fields

Note: ASCII values are enclosed in single quotes (e.g., '1' = ASCII one). Additional information for scan_dir_vote: Scan direction is determined by eight 5-word groups in the telemetry. Currently, if all eight 5-word groups do not resolve to the same value of 0 or 1 for the scan direction, the LPS determines the scan direction from the previous major frame scan direction by interpolation. If there is no previous scan direction available, the LPS will use the single bit values condensed from each group for a simple majority vote to obtain the scan direction. This process will ignore groups that do not condense into a 0 or a 1. The scan_dir_vote field will be set as 1 in this case. If the majority vote does not produce a 0 or 1 solution, then the direction for placing the pixels will be chosen as Forward for MSCD. The scan_dir field will have the value of 'U' for unknown, though, and the scan_dir_vote field will have the value of 2.

3.1.3 PCD File Format (HDF Vdata)

3.1.3.1 PCD File Description

This section presents a detailed format of the LPS output PCD file. The LPS generates separate PCD files for the ETM+ Format 1 and Format 2 data during Level 0Ra processing. The PCD items contained in this file are converted to the engineering units (EUs) identified in the Landsat 7 Wideband Data DFCB. The LPS uses the HDF Vdata structure for producing LPS output PCD files. Table 3-10 defines the HDF Vdata structure for the LPS output file containing PCD data engineering units for the ETM+ Format 1 and Format 2 data.

The LPS output PCD file uses a single/common Vdata structure for reporting each of the major frames received in a PCD cycle. Each PCD major frame is uniquely identified by its associated spacecraft time. This spacecraft time, which is extracted and/or computed from the raw input PCD data, is provided in two different engineering units. The first engineering unit presents the spacecraft time in the Julian day of year and time format. The second engineering unit presents the spacecraft time of a PCD major frame time in seconds since January 1, 1993. The time-in-seconds engineering unit's format is provided by the LPS to comply with the requirement for a searchable time Vdata type in units of seconds.

3.1.3.2 PCD Fill Data

The LPS puts a PCD fill value in the output PCD file fields (Table 3-10) when they cannot be correctly constructed, computed, interpolated and/or flywheeled from the available unpacked PCD words and minor frames in a PCD major frame.

The fill data values for each field are either specified individually or in the group description. The field's cycle_count and majf_count are always calculated and so do not have fill values.

Vdata Name: L7XsssfnYYDOYHHuuv.xxx	where xxx = "PCD" for the PCD file Complete details on the LPS file-naming convention are specified in Section 2.4. There are 179 fields in the PCD file.
Vdata Class: LPS_PCD	
Interlace Type: FULL_INTERLACE	
Bytes Per Logical Record: 26,514	(Excludes HDF overhead)* Maximum file size = ~5.43 MB for a 14-minute subinterval (205 PCD major frames)
Number of Records: One record per PCD major frame (4.096 spacecraft seconds)	

Field Name	Number Type	Order	Description	Remarks
PCD Major Frame Identification Data (not a Vdata table attribute/entry)	-	-	A new PCD major frame is inserted in the PCD file every 4.096 seconds of the spacecraft time. All PCD data are presented in their respective engineering units (EUs) as noted in the Landsat 7 Wideband Data DFCB.	One full PCD major frame consisting of a maximum of 128 minor frames, each containing 128 8-bit words (total 16,384 bytes) is included in each PCD record. No PCD bytes, valid or not, are dropped by LPS. See Landsat 7 Wideband Data DFCB for details on PCD words/bytes.
cycle_count	uint8	1	PCD cycle number (00–99) There are approximately 52 PCD cycles in a 14-minute subinterval.	The PCD cycle number associated with PCD major frame reported in this record of the PCD file. A PCD cycle consists of a set of 4 consecutive PCD major frames: (0), (1), (2), and (3). This number is incremented by 1 for each PCD major frame (0) (identified by spacecraft ID and timecode in words 72 of minor frames 96–102) received in the ETM+ subinterval.
majf_count	uint8	1	PCD major frame counter value (001–255) There could be approximately 206 PCD major frames in a 14-minute subinterval (PCD major frame time = 4.096 seconds).	The major frame counter value of the PCD major frame reported in this record of the subinterval PCD file. The PCD major frame number is incremented by one for each new PCD major frame added to this file.

majf_id	uint8	1	PCD major frame ID (0–3) The PCD major frame ID with a simple majority vote of 5 out of 8 bytes should be considered the prevailing value. Fill value = 255.	The PCD major frame ID is determined by the information contained in word 72, minor frames 96–103 (8 bytes) of each PCD major frame contained in a PCD cycle. PCD major frame (0) is identified by the presence of spacecraft ID and timecode information in the word 72 locations. Other PCD major frames are identified by their ID numbers (1–3).
majf_time	float64	1	PCD major frame time in seconds since January 1, 1993, rounded to 7 decimal places. Fill value = -10.	This time is the PCD major frame time (majf_timecode; see next entry) converted by LPS to seconds since January 1, 1993.
scan_timecode	char8	25	Scan line time of the form 'YYYY:ddd:hh:mm:ss .tttttt' where YYYY: four-digit Julian year ddd = day (01 through 366**) hh = hours (00–23) mm = minutes (00–59) ss = seconds (00–59) tttttt: fractional seconds (0–9999375, where the clock cycle is 1/16 millisecond) Fill value = $$$$... ** For cases when active imaging occurs at the end of a leap year.	For PCD major frame (0), the spacecraft time is extracted from PCD Major frame (0) of a PCD cycle. For PCD major frames 1–3, the spacecraft timecode is interpolated using the spacecraft time received for PCD major frame (0) of the associated PCD cycle. Fill value occurs at the beginning of the PCD file when there has not yet been a valid major frame (0) or if there is a missing cycle.
Selected PCD Items (not a Vdata table attribute/entry)	-	-		
bands_state	char8	8	Indicates ETM+ bands on/off states	This information is extracted from the third PCD major

			for Format 1 and Format 2 data. = 12345678 for all bands in "ON" state for Format 1 and Format 2 data. A "-" indicates an "OFF" state or a missing band (e.g., "123-5678" for Band 4 "OFF". Fill value = $$$$$$$$	frame, minor frame 32, word 72, bits 0–6 and major frame 2, minor frame 35, word 72, bit 0.
fac_flag	uint8	1	Full Aperture Calibration door flag: = 0 indicates no activity = 1 indicates calibration door activity (open and/or imaging) Fill value = 255.	ETM+ Calibration Activity Status. This status is interpolated from "serial word P" of the third PCD major frame, minor frame 84, word 72, bits 2 and 3.
PCD Major Frame Quality and Accounting Data (not a Vdata table attribute/entry)	-	-	Except for majf_flag and timecode_flag which have fill or missing indicators, for an entirely filled major frame the value of 0 should be used.	To maintain consistency with the Landsat 7 Wideband DFCB, the smallest PCD granule is called a "word". A PCD word = an 8-bit byte.
unpacked_pcd_words	uint32	1	= 0–147,538 unpacked PCD words received for this major frame.	Count of unpacked PCD words received for this PCD major frame. For a full major frame the range of values should be between 147,508 and 147,538.
unpacked_words_missing	uint32	1	= 0–147,538 unpacked PCD words missing for this major frame.	Count of unpacked PCD words identified as missing due to missing VCDUs (based on 4 PCD words per VCDU). Some received PCD major frames may contain LPS filled data.
vote_errors	uint16	1	= 0–16384 packed words in a PCD major frame.	Count of (packed) PCD major frame words found to contain voting errors during packing a PCD word/minor frame. Some PCD major

				frame words may contain erroneous or LPS filled data.
minf_sync_ errors	uint8	1	= 0–128 (minor frames per major frame)	Count of PCD minor frames received with sync errors in this major frame. Some PCD words may be lost and filled due to minor frame sync errors.
minf_id_errors	uint8	1	= 0–128 (minor frames per major frame)	Count of PCD minor frames received with incorrect minor frame IDs (counter values). Corrected IDs are filled in.
minf_filled	uint8	1	= 0–128(minor frames per major frame)	Count of PCD minor frames found with erroneous data in PCD words and filled by LPS with a known value.
majf_flag	uint8	1	PCD major frame flag where 0 = valid major frame ID 1= incorrect major frame ID; 2 = missing major frame ID; 3=Non-Applicable; A value of 3 is only used for major frame (0). If in error, the PCD major frame ID is corrected by LPS.	Indicates the quality of the PCD major frame ID found in word 72, minor frames 96–103 of PCD major frames (1), (2), and (3). PCD major frame (0) contains the timecode flag and thus, does not contain the major frame flag. (see below).
timecode_flag	uint8	1	Valid PCD timecode flag, where 0 = valid timecode and spacecraft ID 1 = computed timecode 2 = corrected spacecraft ID 3 = flags 1 and 2 combined 4 = fill value for timecode 5 = fill value for timecode and spacecraft ID	Indicates the quality of the spacecraft ID and timecode data contained in word 72, minor frames 96–103, of PCD major frames (0). For PCD major frames (1) – (3), the timecode flag is also interpolated /derived from the timecode flag used for major frame (0).
PCD Major Frame Data (not a Vdata table				

attribute/entry)				
spacecraft_id	char8	1	spacecraft_id = "7"	The Landsat 7 spacecraft ID is determined from bytes 0–3 of PCD timecode word 96 located in major frame (0) of each PCD cycle. For the remaining three major frames in a PCD cycle, this spacecraft ID is copied for each major frame. The spacecraft ID is also forced to "7" when an erroneous ID is read or the spacecraft ID is missing. The spacecraft ID error is noted in the s/c_id_err_pcd field.
sv_clk_last_update_time	float64	1	sv_clk_last_u/d_time = 0–31,622,400 seconds from midnight of the first day of the current year. Fill value = -1.0 This time is presented as a double precision floating point number in HDF to accommodate the 48-bit extended precision floating point value/sample received in the PCD data.	See L7 DFCB Section 3.2.7.4.6 for details on the SV clock last update time.
time_drift_bias_c0	int16	1	Spacecraft time drift bias (C0) = +/- milliseconds Fill value = 7FFF	See L7 DFCB Section 3.2.7.4.7 for details on the SV (spacecraft) time drift characterization data.
time_drift_rate_c1	int16	1	Spacecraft clock drift rate (C1) = +/- milliseconds/day Fill value = 7FFF	See above
time_drift_acceln_c2	int16	1	Spacecraft clock drift acceleration (C2) = +/- milliseconds/day^2	See above

			Fill value = 7FFF	
ETM+ TLM @ 4.096 seconds rate (not a Vdata table attribute/entry)	-	-	Repeat the following PCD values for each PCD major frame. If a major frame does not contain the required PCD value, fill these with all ones (FF in hexadecimal for uint8, FFFF for uint16).	The following PCD values should be copied in the same format as found in their respective PCD words/minor frames in a PCD major frame.
black_body_ temp_iso	uint8	1	Black Body Temperature (Isolated)	See above
cfpa_heater_ current	uint8	1	CFPA Heater Current	See above
cal_shutr_flag_ temp	uint8	1	Calibration Shutter Flag Temperature	See above
backup_shutr_ flag _temp	uint8	1	Backup Shutter Flag Temperature	See above
black_body_ temp_con	uint8	1	Black Body Temperature (Control)	See above
baffle_temp_ heater	uint8	1	Baffle Temperature (Heater)	See above
cfpa_control_ temp	uint8	1	CFPA Control Temperature	See above
pdf_ad_ground _ref	uint16	1	PDF A/D Ground Reference	Only the 12 ground reference bits G0-G11 are included and not the constant first four bits found in minor frame 116 of word 72. See L7 DFCB Section 3.2.7.4.12
ETM+ TLM @16.384 seconds Rate (not a Vdata table attribute/entry)	-	-	Repeat the following PCD values for each PCD major frame. If a major frame does not contain the required PCD value, fill these with all ones (FF in hexadecimal).	The following PCD values should be copied in the same format as found in their respective PCD words/minor frames in a PCD major frame.
serial_words_ a_s	uint8	18	Serial Word "A" components: a, b, c, d, e, f, g, h, i, j, k, l, m, n, p, q, r, s	See above
mux_elec_ temp	uint8	1	Active Mux Electronics Temperature	See above

mux_ps_ temp	uint8	1	Active Mux Power Supply Temperature	See above
tec_lamp_1i	uint8	1	Calibration Lamp #1 Current	See above
tec_lamp_2i	uint8	1	Calibration Lamp #2 Current	See above
acs_cpu_mode	uint8	1	ACS CPU Mode	See above
etm_tlm_mnf_ 16_30	uint8	15	ETM TLM MF(2), mfs(16–30)	See above. Also, the contents extracted from minor frames 16-30 are as follows: 16 EM Heat Sink Power Supply # 1 Temp 17 Silicon Focal-Plane Assembly Temp 18 Zero Fill 19 Baffle Temperature (Tube) 20 MEM Heat Sink Power Supply # 2 Temp 21 Cold FPA Monitor Temperature 22 Baffle Temperature (Support) 23 Cal Lamp Housing Temp 24 Scan-Line Corrector Temp 25 Cal Shutter Hub Temp 26 Ambient Preamp Temp (High Channels) 27 Band 4 Post Amp Temp 28 Zero Fill 29 Band 7 Preamp Temp 30 Ambient Preamp Temp (Low Channels)
etm_tlm_mnf_ 40_49	uint8	10	ETM TLM MF(2) mfs(40–49)	See above. Also, the contents extracted from minor frames 40-49 are as follows: 40 Primary Mirror Temp 41 Primary Mirror Mask Temp 42 Secondary Mirror Temp 43 Secondary Mirror Mask Temp 44 Telescope Housing Temp 45 Telescope Baseplate Temp

				46 Pan Band Post Amplifier Temp 47 -49 Zero Fill
etm_plus_on_ time	float64	1	Time ETM+ was last on: etm_plus_on_time = 0–31,622,400 seconds from midnight of the first day of the current year. Reported for each PCD major frame (0) record. If a PCD major frame (1, 2, or 3) does not contain the required PCD value. Fill value = -1.0	See L7 DFCB Sections 3.2.7.4.6 and 3.2.7.4.16 for details on this time. Reported as an HDF double precision floating point number to accommodate the 48-bit extended precision floating point value/sample received in major frame (0) of a PCD cycle.
etm_plus_off_ time	float64	1	Time ETM+ was last off: See above for related description.	See above
Ephemeris Data (not a Vdata table attribute/entry)		-	The ephemeris data, consisting of the position and velocity components, is available on a PCD major frame basis.	See L7 DFCB Section 3.2.7.4.8 for details on the ephemeris data. Note: The ephemeris data source minor frame locations change for odd and even numbered major frames (0–3).
ephem_ position_xyz	float64	3	Includes position components: x, y and z Position Range: +/- 8.3886 x 106 meters Fill value = 107	See above
ephem_ velocity_xyz	float64	3	Includes velocity components: x, y and z Velocity Range: +/- 8.0 meters/milliseconds Fill value = 10	See above
Attitude Estimate (not a Vdata table attribute/entry)	-	-		See Landsat 7 Wideband Data DFCB Section 3.2.7.4.5 for word/minor frame locations of attitude data in PCD major frames.

attitude_est_epa1234	float64	4	Attitude Euler parameters: EPA1, EPA2, EPA3 and EPA4 Fill value = 2	Same as above
gyro-select_x	Char8	1	= "A" for Gyro channel A selected, or = "B" for Gyro channel B selected Fill value = $	Bit 0 of minor frame 34 in subcom word 72 of PCD major frame 0 identifies the gyro channel selected for the X-axis. 1=A, 0=B as described in section 3.2.7.4.17 of the L7 DFCB.
gyro-select_y	Char8	1	= "A" for Gyro channel A selected, or = "B" for Gyro channel B selected Fill value = $	Bit 1 of minor frame 34 in subcom word 72 of PCD major frame 0 identifies the gyro channel selected for the Y-axis. 1=A, 0=B as described in section 3.2.7.4.17 of the L7 DFCB.
gyro-select_z	Char8	1	= "A" for Gyro channel A selected, or = "B" for Gyro channel B selected Fill value = $	Bit 2 of minor frame 34 in subcom word 72 of PCD major frame 0 identifies the gyro channel selected for the Z-axis. 1=A, 0=B as described in section 3.2.7.4.17 of the L7 DFCB.
Gyro (IMU Axes) Data (not a Vdata table attribute/entry)	-	-	Note: The following IMU axes (x, y, z) readings are repeated 64 times in each major frame. The IMU axes values are in arc-seconds of angular motion. A total of 256 readings (samples) are collected for each PCD cycle. The Gyro data order is as follows :- all 64 roll values (Roll-1, Roll-2...) - all 64 pitch values (Pitch-1, Pitch-2...) - all 64 yaw values (Yaw-1, Yaw-2...) Fill values are MAXFLOAT	See L7 DFCB Section 3.2.7.4.3 for details on gyro data. Each IMU axes counter value is first constructed by concatenating the three bytes for each axis (e.g., x1, x2, and x3) and then converting to arc-seconds. For converting the IMU counter values to engineering units, each increment or decrement in the 24-bit counter value of an IMU axes represent a 0.061 arc-second change. The data is in the IMU reference frame. To convert to the spacecraft reference frame use the Gyro to Attitude Matrix in the CPF. IMU X corresponds to s/c roll. IMU Y corresponds to

				s/c yaw. IMU Z corresponds to s/c negative pitch.
imu_x_roll_x00_x63	float64	64	= - 511705.088 to + 511705.027 arc-seconds for components x00 – x63 in the PCD major frame.	See above
imu_y_pitch_y00_y63	float64	64	= - 511705.088 to + 511705.027 arc-seconds for components y00 – y63 in the PCD major frame.	See above
imu_z_yaw_z00_z63	float64	64	= - 511705.088 to + 511705.027 arc-seconds for components z00 – z63 in the PCD major frame.	See above
Gyro Drift Data(not a Vdata table attribute/entry)		-	Note: The Gyro drift data is reported once per PCD cycle in major frame (0) only.	See L7 DFCB Section 3.2.7.4.4 for details on the Gyro Drift data.
gyro_drift_theta_xyz	float64	3	Includes components: x, y and z. The units of gyro drift (rate) data for each axis are in radians/second. Fill value = -1.0	The least significant bit weight of the theta value is adjusted to 2-47 before converting to engineering units. The input format is 2's complement integer data. Further conversion to engineering units is not done by LPS and must use elements of the CPF.
Angular Displacement Sensor Data (ADS) (not a Vdata table attribute/entry)	-	-	Note: The following fields are repeated for each minor frame in the PCD major frame. The minor frame ID (mnfm_ids_000_127) is reported once for a total of 16 sets of ADS x, y, z values. The 16 sets of ADS x, y, z values are reported for each of the 128 minor frames in a PCD major frame.	See L7 DFCB Section 3.2.7.4.1 for details on ADS data. A total of 16 ADS measurements, each consisting of the x, y and z components, are received in a PCD minor frame.

			All ADS x, y, z measurements are converted to micro radians and reported in ascending order of their source words and minor frames in a PCD major frame. All data is reported with single floating point precision. Fill value for all including mnfm_ids_000_127 is 255.	
mnfm_ids_000_127	uint8	128	Minor frame ID (counter) components: 000 - 127	The PCD minor frame counter value/ID from word location 65 of each minor frame. There are 128 (IDs: 000–127) minor frames in a PCD major frame.
ads_xyz16_mnfm_000	float32	48	x01, y01, z01, x02, y02, z02, ... x16, y16, z16	(See above)
ads_xyz16_mnfm_001	float32	48	x01, y01, z01, x02, y02, z02, ... x16, y16, z16	(See above)
•••			A total of 16 sets of ads x, y, and z components are reported for each minor frame (000 - 127).	(See above)
ads_xyz16_mnfm_127	float32	48	x01, y01, z01, x02, y02, z02, ... x16, y16, z16	(See above)
ADS Temperatures(not a Vdata table attribute/entry)	-	-	Note: The ADS x, y, z and A/D electronic temperature values are reported on a major frame basis. All temperatures are reported in degrees Centigrade (°C).	See L7 DFCB Section 3.2.7.4.2 for details.
ads_temp_xyz_plus_ad	float32	4	Includes temperature values for components: x, y, z and elec_a/d	(See above)

			Fill value = 255	
PCD Quality and Accounting Data(not a Vdata table attribute/entry)			The following PCD quality data is produced by LPS and appended to each major frame record of the PCD file.	
sc_id_err_pcd	char8	1	Spacecraft ID error in PCD: s/c_id_err_pcd = "n" for no errors, "y" for errors detected in the spacecraft ID field	The error flag is true whenever the spacecraft ID is not equal to "7" and is corrected to "7".
att_data_ quality	char8	1	Attitude Data Point Quality: att_data_quality = "g" for a good data, "r" for rejected data, "m" for missing data	Determined and produced by LPS for each PCD major frame. "r" indicates that the attitude data is rejected due to failed range check. "m" indicates attitude data was found missing and is replaced with fill data.
ephem_data_ quality	char8	1	Ephemeris Data Point Quality: ephem_data_quality = "g" for a good data "r" for rejected data "m" for missing data	Determined and produced by LPS for each PCD major frame. "r" indicates that the ephemeris data is rejected due to failed range check. "m" indicates ephemeris data was found missing and is replaced with fill data.

Table 3-11. PCD File - HDF Vdata Definition and Fields

3.1.3.3 PCD Conversion to Engineering Units (EUs)

This section contains notes and information for converting the Landsat 7 raw PCD, as necessary, to the Landsat 7 PCD engineering units (EUs). The Landsat 7 raw PCD format is specified in the Landsat 7 Wideband Data DFCB. The PCD engineering unit notes are provided as a reference and to assist the developers in generating the LPS output PCD file specified in Table 3-17. These notes and/or information do not constitute a part of the LPS output PCD file format (Table 3-17).

3.1.3.3.1 ADS to Data EUs

3.1.3.3.1.1 Data Extraction (Ref. L7 DFCB, Section 3.2.7.4.1)

ADS Sample size: 12 bits
ADS Sample Source: 2 PCD minor frames (16 bits)

msb lsb
0000 XXXX XXXX XXXX

where Xs indicate the 12 bits of an ADS sample.
The least significant bit value = 125/211 or = 125/2048

ADS Sample Value: 0 - 212 or 0 - 4095, where:

0 is the maximum negative angular displacement value,
2048 is the nominal zero angular displacement value, and
4095 is the maximum positive angular displacement value

3.1.3.3.1.2 Conversion to Engineering Units (EUs)\

EU = (ADS Sample Value - ADS Sample Value for the Nominal Zero angular Displacement)* 125/211 micro radians, OR
= (ADS Sample Value – 2048)* 125/2048, OR
= (ADS Sample Value – 2048)*0.0610352

3.1.3.3.1.3 Examples

a. For an ADS Sample Value = 0

The ADS EU Value = (0-2048)*125/2048 = -125 micro radians

b. For an ADS Sample Value = 1024

The ADS EU Value = (1024-2048)*125/2048 = -62.5 micro radians

c. For an ADS Sample Value = 2048

The ADS EU Value = (2048 - 2048) * 125/2048 = 0 micro radians

d. For an ADS Sample Value = 4095

The ADS EU Value = (4095-2048)*125/2048 = 124.93896 micro radians

3.1.3.3.2 ADS Temperature EUs

3.1.3.3.2.1 Data Extraction (Ref. L7 DFCB, Section 3.2.7.4.2)

ADS Temperature Sample size: 12 bits
ADS Temperature Sample Source: 2 PCD minor frames (16 bits)

msb lsb
0000 XXXX XXXX XXXX

where Xs indicate the 12 bits of an ADS Temperature sample.
The least significant bit value = 0.0122 degrees Centigrade (L7 DFCB Table 11).

ADS Temperature Sample Value: 000016 - 0FFF16 OR 0 - 4095, where:

0 = +50 degrees Centigrade, and
4095 = 0 degrees Centigrade

3.1.3.3.2.2 Conversion to Engineering Units (EUs)

= (Max. ADS Temperature Sample Value - ADS Temperature Value) *
50/4096 degrees Centigrade,
— OR —

= (4095 - ADS Temperature Value) * 0.01220703125 degrees Centigrade

3.1.3.3.2.3 Examples

a. For an ADS Temperature Sample Value = 0

The ADS Temperature EU Value = (4095 - 0) * 0.01220703125 = 49.987792969 degrees Centigrade

b. For an ADS Temperature Sample Value = 2047

The ADS Temperature EU Value = (4095 - 2047) * 0.01220703125 = 25.0 degrees Centigrade

c. For an ADS Temperature Sample Value = 4095

The ADS Temperature EU Value = (4095 - 4095) * 0.01220703125 = 0 degrees Centigrade

3.1.3.3.3 Gyro Data EUs

3.1.3.3.3.1 Data Extraction (Ref. L7 DFCB, Section 3.2.7.4.3)

There are three gyros with two output channels, A and B, each corresponding to the rates for two of three axes (X, Y, and Z). Therefore two measurements, A and B, are available for each axis. The Gyro outputs are configured as follows:

Gyro 1: output channels YA and ZA
Gyro 2: output channels XA and ZB
Gyro 3: output channels XB and YB

There is telemetry in the PCD to indicate which channel for each axis is sent down in the PCD, A or B. A change in the channels being sent down in the PCD should not affect the LPS processing.

Gyro Data Sample Readings: 3 (X, Y and Z)
Gyro Data Sample Reading Size: 24 bits

Gyro Data Sample Reading Source: 3 PCD minor frames (24 bits)

msb lsb
SXXX XXXX XXXX XXXX XXXX XXXX

where Xs indicate the 23 bits of a gyro data sample reading with S as the sign bit.
The least significant bit value = 0.061 arc-seconds of angular motion

Gyro Data Sample Reading Values: -223 to +223 -1 OR
-8,388,607 to +8,388,606
where the engineering unit equivalents are:

-8,388,607 = -511,705.027 arc-seconds
0 = 0 arc-seconds
+8,388,606 = +511,704.966 arc-seconds

3.1.3.3.3.2 Conversion to Engineering Units

= Gyro Data Sample Reading * 0.061 arc-seconds

3.1.3.3.3.3 Examples

For Gyro Sample Readings:

- IMU-X (Roll) = -1023
- IMU-Y (Pitch) = 0
- IMU-Z (Yaw) = +2047

The Gyro engineering unit values are:

- IMU-X (Roll) = -1023*0.061 = -62.403 arc-seconds
- IMU-Y (Pitch) = 0*0.061 = 0 arc-seconds
- IMU-Z (Yaw) = +2047*0.061 = +124.867 arc-seconds

3.1.4 Calibration Data File Format (HDF-EOS Swath)

3.1.4.1 Calibration Data File – Swath Format Overview

The LPS uses the HDF-EOS Swath object structure for generating LPS calibration data files. An LPS calibration data file contains all HDF-EOS Swath objects required for all bands of the calibration data in an ETM+ Format 1 or Format 2 subinterval. A swath object for each band of the calibration data, present in an ETM+ format, is provided by LPS. The calibration data swath file for an ETM+ Format 1 subinterval consists of six swath objects, arranged in band sequential order, one each for Bands 1–6. The calibration data swath file for an ETM+ Format 2 subinterval consists of three swath objects, one each for Bands 6–8. Figure 3-3 and Figure 3-5 provide an overview of the HDF-EOS swath structure for the LPS output calibration file.

Each calibration swath object consists of cal. data fields and cal. geolocation fields. Cal. data fields in a swath contain cal. data lines from one band. The geolocation fields provide identification and construction information for each cal. line in a swath. A dimension map provides the linkage between geolocation fields to its associated cal. data line. Table 3-11 and Table 3-16 define the calibration swath.

3.1.4.2 Calibration Data File Volume(s)

The following sizing assumptions are used to define the range of values included in the calibration file:

1. ETM+ Scans per Scene:

   - Nominal: 335 (Received WRS scene without scans overlap)
   - Maximum: 375 (Distribution WRS scene with scans overlap)

2. Scan Data Lines (Nominal, without scans overlap) per Scene:

   - Bands 1–5 and 7: 335 x 16 = 5,360
   - Band 6: 335 x 8 = 2,680
   - Band 8: 335 x 32 = 10,720

3. Scan/Cal Data Lines (Maximum with scans overlap) per Scene:

   - Bands 1–5 and 7: 375 x 16 = 6,000
   - Band 6: 375 x 8 = 3,000
   - Band 8: 375 x 32 = 12,000

4. Subinterval Duration: ~14 minutes (Maximum)
   (Longest possible contact period duration - worst case)

5. Scene Duration: ~ 24 seconds

6. Number of Scenes (Maximum) per Subinterval: ~ 35
   (For the longest possible contact period with a single subinterval)

7. ETM+ Scans per Subinterval (scans do not overlap):
Maximum: 335 x 35 = 11,725

8. Scan/Calibration Data Lines (Maximum) per Subinterval (scans do not overlap):

   - Bands 1–5 and 7: 5,360 x 35 = 187,600
   - Band 6: 2,680 x 35 = 93,800
   - Band 8: 10,720 x 35 = 375,200

9. Calibration Data Line Lengths (Received, Nominal):

(Calibration Data [DC Restore Data + Calibration Data + Garbage Data] + Fill Code Data)

- Bands 1–5 and 7: 986 + 164 = 1,150 Bytes
  (Check: Total Line Length - Active Scan Length = 7,473 - 6,323 = 1,150)
- Band 6: 1,150 / 2 = 575 Bytes
- Band 8: 1,150 x 2 = 2300 Bytes

10. LHS Margins: Alignment + Bumper Wear + Extra

- Band 1: 40 Bytes
- Band 2: 65 Bytes
- Band 3: 90 Bytes
- Band 4: 115 Bytes
- Band 7: 160 Bytes
- Band 5: 186 Bytes
- Band 6: 110 Bytes
- Band 8: 30 Bytes

11. RHS Margins: Alignment Space + Bumper Wear + Extra

- Bands 1-5, 7: RHS = 1450 - LHS - 1150
- Bands 6: RHS = 725 - LHS - 575
- Band 8: RHS = 2900 - LHS - 2300
- Band 1: 260 Bytes
- Band 2: 235 Bytes
- Band 3: 210 Bytes
- Band 4: 185 Bytes
- Band 7: 140 Bytes
- Band 5: 114 Bytes
- Band 6: 40 Bytes
- Band 8: 570 Bytes

12. Calibration Data Output Line Lengths (Based on Band 1 margins):

(Nominal + LHS side Margin + RHS Margin)

- Band 1–5 and 7: 1,150 + 40 + 260 = 1450 Bytes
- Band 6: 575 + 20 + 130 = 725 Bytes (or 1450/2)
- Band 8: 2,300 + 80 + 520 = 2900 Bytes (or 1450 x 2)

13. Subinterval Calibration Data File Volumes (Maximum):

- Band 1–5 and 7: 187,600 x 1,450 = ~ 0.272 GB
- Band 6: 93,800 x 725 = ~ 0.068 GB
- Band 8: 375,200 x 2,900 = ~ 1.088 GB

14. Calibration Data File Volume (All Subinterval Bands, Maximum):
    Format 1: (Bands 1–6): 0.272 x 5 + 0.068 = 1.428 GB
    Format 2: (Bands 6–8): 0.068 + 0.272 + 1.088 = 1.428 GB

3.1.4.3 Calibration Fill Data

Calibration data will be filled similarly to Band data. See section 3.1.1.3.

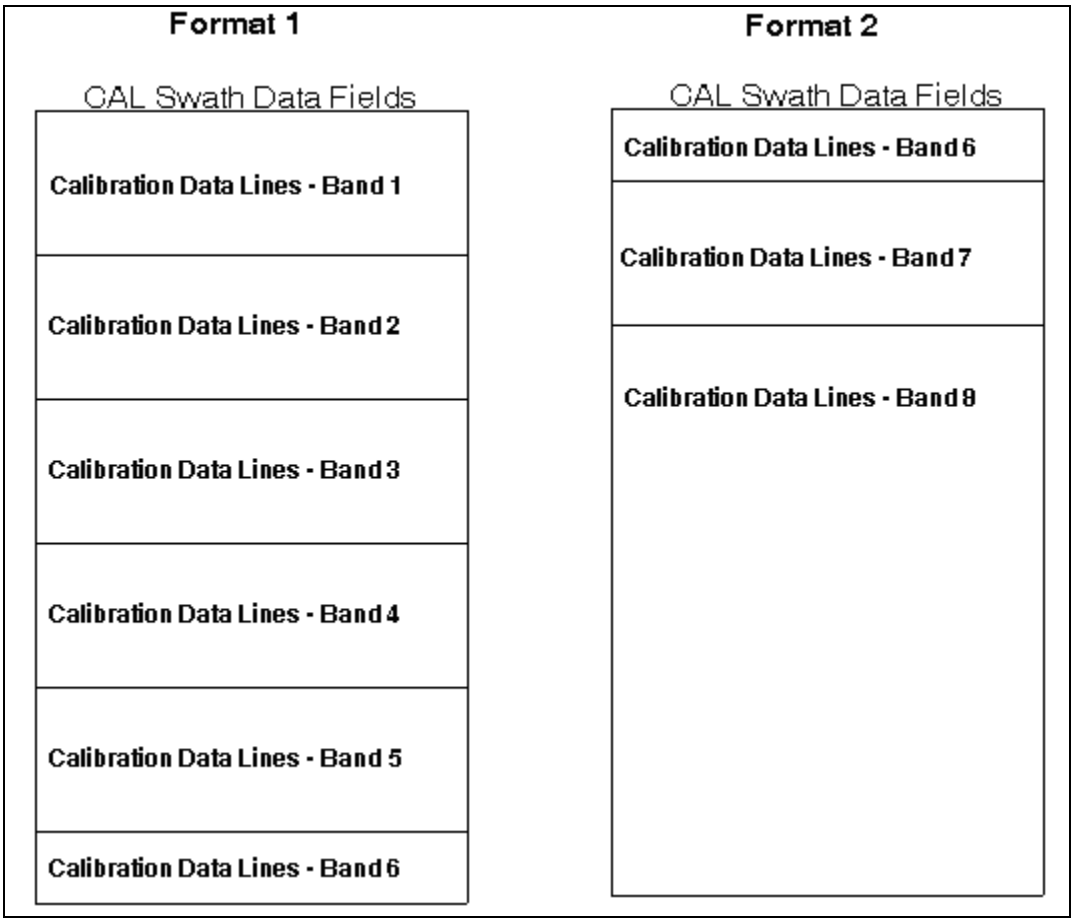

Figure 3-3. Format 1 and 2 Calibration Data Files

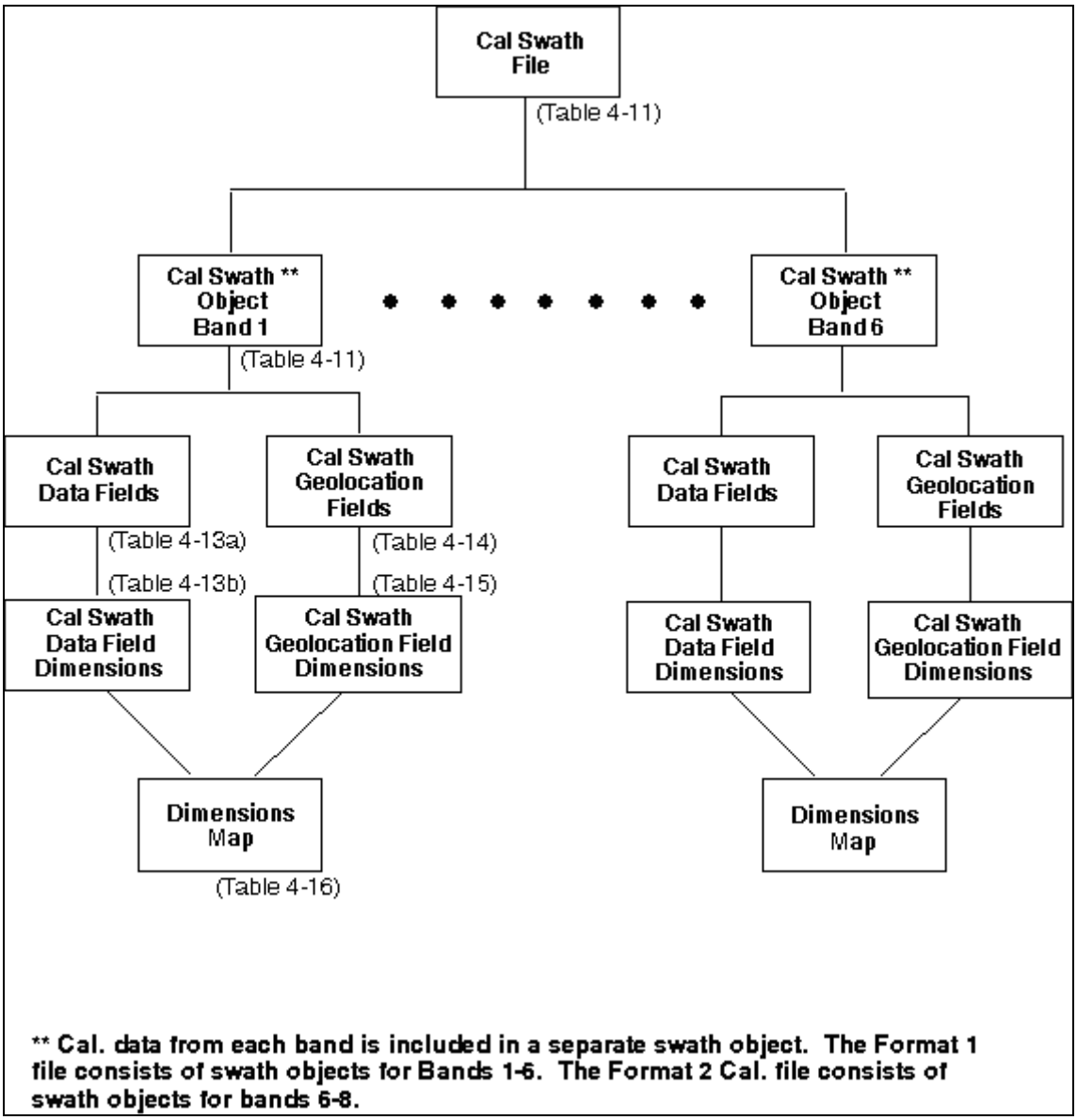

Figure 3-4. Calibration Data File (Format 1 Example) HDF-EOS Swath Structure

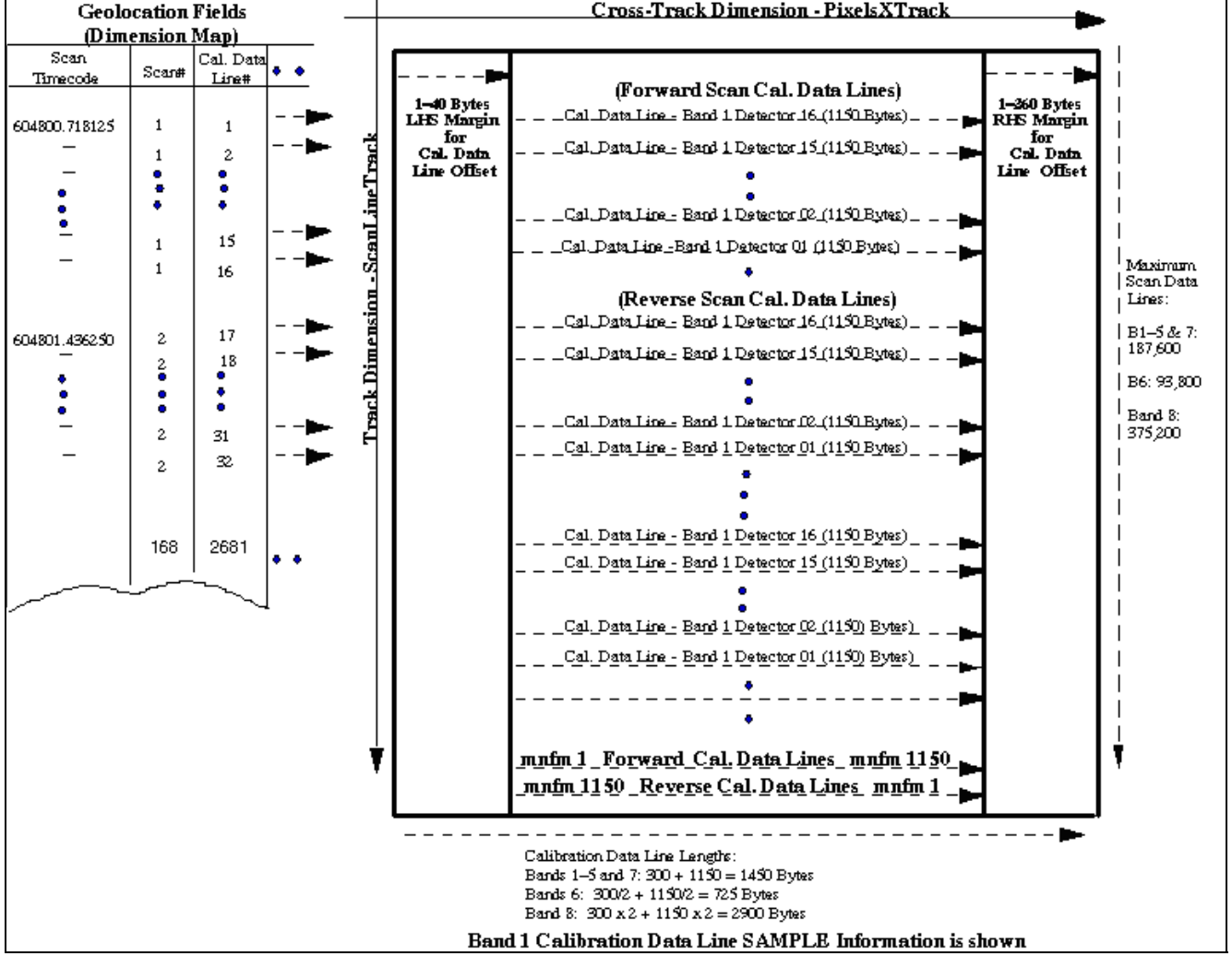

Figure 3-5. Calibration Data File - ECS-HDF Swath Overview

Swath Definition Parameter	Number Type and (Size)	Value, Format, Range and Unit	Parameter Description / Remarks
file_name	char8 (22)	= L7XsssfnYYDOYHHuuv.xxx where xxx = CAL for a calibration data file.	See Section 2.4 for complete details on the LPS file naming convention. The LPS generates a calibration data file each for the ETM+ Format 1 and Format 2 data subintervals.
swath_name	char8(13)	= Cal_Swath_Cis where "Cal_Swath_" identifies a Landsat 7 calibration data HDF-EOS swath object. One calibration data swath object is produced for each band in an ETM+ format, Format 1 or Format 2. All calibration data swath objects for an ETM+ format are included (grouped) in a single calibration data file (file name shown above). Cis identifies ETM+ Format 1 and Format 2 calibration data source bands as follows: Ci = C1–C8 for Calibration data source Bands 1–8 s = 0 for single segment swaths for Bands 1–6 in an ETM+ Format 1 calibration data file s = 0 for single segment swaths for Bands 6–8 in an ETM+ Format 2 calibration data file.	Defined in accordance the xxx = "Bis" extension used in the LPS file naming convention. The Format 1 calibration data file contains the following calibration data swaths (names): = Cal_Swath_C10 = Cal_Swath_C20 = Cal_Swath_C30 = Cal_Swath_C40 = Cal_Swath_C50 = Cal_Swath_C60 The Format 2 calibration data file contains the following calibration data swaths (names): = Cal_Swath_C60 = Cal_Swath_C70 = Cal_Swath_C80 Note: Calibration data for Band 8 is not segmented into multiple swaths or Calibration Files.

Table 3-12. Calibration Data File and Swath Definition Parameters

Attribute Name	Number Type (ntype)	Count	Attribute Values	Remarks
detector_count	int8	1	= 16 for Bands 1–5 and 7, = 8 for Band 6, and = 32 for Band 8	

Table 3-13. Calibration Data File - CAL Swath Attributes

Data Field Name	Number Type	Count	Value	Remarks
cal_band_detector_data	uint8	1450	= 20-255 (grays cal pixel data)	Cal. data (bytes) is extracted from a single detector of a band to form a cal. data line. The number of cal. data lines formed for each band depends on detector_count (Table 3-12). A cal. data line consists of band_detector data from each minor frame starting with the End-of-Line (EOL) minor frame until the start of a new scan. See Section 3.1.4.2 for detail on cal. data line components and maximum number of lines for a band.

Table 3-14. Calibration Data File - CAL Swath Data

Data Field Name	Number Type	Cross-Track Dimension Name and Size	Track Dimension Name and Size	Merge Code
cal_band_ detector_data	uint8	Name: PixelsXTrack Size: = 1,450 for Bands 1–5 and 7 = 725 for Band 6 = 2,900 for Band 8 Notes: This dimension includes the End-of-Line (EOL) and Scan Line Direction (SLD) minor frame data as follows: = 2 for Bands 1–5 and 7 = 1 for Band 6 = 4 for Band 8	Name: ScanLineTrack Size: scan_no x detector_count where scan_no = 1–11,725 and detector_count is as defined in Table 3-12. The possible range for ScanLineTrack Size = 1–187,600 for Bands 1–5 and 7 = 1–93,800 for Band 6 = 1–375,200 for Band 8	= HDFE_NOMERGE (0) (no merge) Keep calibration data swaths separate for each band.

Table 3-15. Calibration Data File - CAL Swath Data Field Dimensions

Geolocation Field Name	Number Type	Count	Value	Remarks
scan_timecode	char8	25	Scan line time of the form 'YYYY:ddd:hh:mm:ss.tttttt' Where YYYY: four-digit Julian year ddd: day (01 through 366**) hh: hours (00 through 23) mm: minutes (00 through 59) ss: seconds (00 through 59) tttttt: fractional seconds (0–9999375, where the clock cycle is 1/16 millisecond) ** For cases when active imaging occurs at the end of a leap year.	The ETM+ scan start time extracted from the timecode minor frames of the ETM+ major frame data reported in this record. A computed scan start time is provided if a valid time is not available from the ETM+ time code minor frames.
Time	float64	1	The ETM+ scan time in seconds since midnight on January 1, 1993, rounded to 7 decimal places.	The scan time is obtained by converting the scan_timecode (see above) to seconds.
scan_no	uint16	1	scan_no = 1–11,725 The maximum scan count is based on a subinterval duration of 14 minutes for 35 scenes, each consisting of 375 (355+20) scans.	Provides a sequence counter for ETM+ scans (major frames) contained in a subinterval. The ETM+ scan counter is incremented by one for each new scan, real or flywheeled, added to the subinterval file.
cal_data_line_no	uint32	1	cal_data_line_no = SSSSSS where SSSSSS = 1–187,600 for Bands 1–5 and 7 = 1–93,800 for Band 6 = 1–375,200 for Band 8 Note: All Band 8 calibration data lines are included in a single swath (not segmented like the band swath). See Section 3.1.4.2 for details.	The cal. data line counter is incremented for each calibration data line added to the calibration data swath.

scan_dir	char8	1	Scan direction character 'F' = Forward scan 'R' = Reverse scan 'U' = Unknown scan direction	The current ETM+ scan direction information obtained directly from the word 5, bit 1 of the PCD/Status data for the current scan. A valid ETM+ major frame has no errors. The default Forward direction will be used as the scan direction for the scan for the purpose of placing the data if the direction is unknown.
detector_id	uint8	1	where detector_id is in the range: = 1–16 for Bands 1–5 and 7 = 1–8 detectors for Band 6 = 1–32 for Band 8	Each data line in a calibration data swath consists of pixel data (bytes) from a single detector of a single band (see Figure 3-5). Each detector, chosen in a descending ID order, is used once during each scan for generating a scan line.
cal_data_line_offset_rhs	int16	1	= 0–300 bytes for Bands 1–5 and 7= 0–150 bytes for Bands 6 (Format 1 and Format 2) = 0–600 bytes for Band 8. The cal. line data may be shifted to right in the band data buffer after an integer-pixel alignment. The maximum value in the above ranges represents the sum of the RHS plus LHS offsets before bumper wear.	The calibration line data in each record of the calibration data swath is initially written with a predetermined size of byte offset on the left and right of the designated scan line data area with a pattern of zeros. During integer-pixel alignment, these offsets provide moving in space (to avoid data loss) for

				the right-shifted band-detector data. After an integer-pixel alignment, this field indicates the resulting start and stop bytes/pixel positions for scan lines. This offset also accommodates scan line length growths due to ETM+ scanner bumper wear. (See Figure 3-5)
cal_data_line_offset_lhs	int16	1	= 0–300 bytes for Bands 1–5 and 7= 0–150 bytes for Band 6 = 0–600 bytes for Band 8. The cal. line data may be shifted to left in the band data buffer after an integer-pixel alignment.	Note: The left-hand-side offset is not as significant as the right-hand-side margin. It can accommodate scan/cal. line length growths due to ETM+ scanner bumper wear. (See Figure 3-5) This value is dependent on values in the calibration parameter file.

Table 3-16. Calibration Data File - CAL Swath Geolocation Fields

Geolocation Field Name	Number Type	Track Dimension Name and Size	Merge Code
scan_timecode	char8	Name: TimecodeTrack, StringSize: 1–11,725	= HDFE_AUTOMERGE (1)(OK to merge fields with shared dimensions and/or data type)
Time	float64	Name: TimeTrackSize: 1–11,725	= HDFE_AUTOMERGE (1)
scan_no	uint16	Name: ScanTrackSize: 1–11,725	= HDFE_AUTOMERGE (1)
cal_data_line_no	uint32	Name: ScanLineNoTrackSize: 1–11,725 x detector_count(See Table 3-12)	= HDFE_AUTOMERGE (1)
scan_dir	char8	Name: ScanDirTrackSize: 1–11,725	= HDFE_AUTOMERGE (1)
detector_id	uint8	Name: DetectorIdTrackSize: 1–11,725x detector_count(See Table 3-12)	= HDFE_AUTOMERGE (1)
cal_data_line_ offset_rhs	int16	Name: RhsOffsetTrackSize: 1–11,725 x detector_count(See Table 3-12)	= HDFE_AUTOMERGE (1)(merge)
cal_data_line_ offset_lhs	int16	Name: LhsOffsetTrackSize: 1–11,725 x detector_count(See Table 3-12)	= HDFE_AUTOMERGE (1)(merge)

Table 3-17. Calibration Data File - CAL Swath Geolocation Field Dimensions

Geolocation Dimension Name	Data Dimension Name	Offset	Increment
TimecodeTrack	ScanLineTrack	= 0 The timecode starts with the first scan line.	= detector_count The timecode repeats at detector count intervals.
TimeTrack	ScanLineTrack	= 0	= detector_count
ScanTrack	ScanLineTrack	= 0	= detector_count
ScanLineNoTrack	ScanLineTrack	= 0	= 1
ScanDirTrack	ScanLineTrack	= 0	= detector_count
DetectorIDTrack	ScanLineTrack	= 0 The detector ID starts with the first scan line.	= 1 The detector ID repeats on a scan line basis.
LhsOffsetTrack	ScanLineTrack	= 0 The left-hand side offset starts with the first scan line.	= 1 A left-hand side offset is present for each scan line.
RhsOffsetTrack	ScanLineTrack	= 0	= 1
String [Size 25]	N/A	N/A	N/A

Table 3-18. Calibration Data File - HDF Swath Dimension Map

3.2 Metadata File Format (ODL)

3.2.1 Metadata File Description

The LPS generates individual metadata files for the ETM+ Format 1 and Format 2 subintervals. These files consist of two levels of metadata: the subinterval and the WRS scene level. The subinterval level metadata contains reference information on the subinterval raw wideband data source (e.g., an LGS X-band channel), the LPS resources (equipment strings) used in Level 0Ra processing, and identification information on the Level 0Ra data files produced for a Format 1 or a Format 2 subinterval. The WRS scene level metadata contains information on each WRS scene identified for a subinterval during Level 0Ra processing. The WRS scene level metadata is further divided into scene metadata groups. Each scene metadata group contains identification information on a WRS scene, its geolocation references (e.g., scene center and corner information), its cloud cover assessment scores, and quality and accounting information on the band (image) and payload correction data associated with the WRS scene. The WRS scene level metadata may contain information on up to 35 full WRS scenes for a 14-minute Landsat 7 contact period.

The LPS metadata file for a Format 1 subinterval contains subinterval level and WRS scene level metadata for Bands 1–6. The LPS metadata file for a Format 2 subinterval contains subinterval level and WRS scene level metadata for Bands 6–8. The multiband scene browse file names and the automated cloud cover assessment (ACCA) results are provided in the ETM+ Format 1 (Bands 1–6) subinterval metadata only. Section 3.2.3 contains examples of the LPS Format 1 and Format 2 subinterval metadata files.

The LPS metadata file format conforms to the Object Description Language (ODL) standard. Table 3-17 provides details on LPS parameter values and their formats for constructing the ETM+ Format 1 and Format 2 metadata files. In accordance with the ODL standard, all parameters and values are presented using ASCII standard characters.

The following notes apply to the construction of LPS metadata statements:

1. Leading zeros are omitted from all values except for parameters associated with WRS path and row (e.g., WRS_PATH and WRS_ROW) and in the metadata GROUP and END_GROUP statements (including a multiple digit field).
2. All fixed length character strings, including single character strings such as "+", "-", "Y", and "N" characters, are enclosed with quotes (" "). This includes file names.
3. All values equal to or greater than zero (0) are considered positive. All values less than zero (0) are considered negative. Plus signs "+" are not explicitly needed in front of positive values.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
GROUP	13	= METADATA_FILE	Beginning of the first level ODL group. It indicates the start of the LPS Metadata File Level Group records for an ETM+ Format 1 or Format 2 subinterval.
GROUP	18	= METADATA_FILE_INFO	Beginning of the second level ODL group. It indicates the start of the LPS Metadata File information Group records.
FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" where xxx = "MTA" for the metadata file.	Complete details on the LPS file naming convention are specified in Section 2.4.
FILE_ CREATION_ DATE_TIME	20	= YYYY-MM-DDThh:mm:ssZ where YYYY = four-digit Julian year (e.g., 1998 and 2001) MM = month number of a Julian year (01–12 for January to December) DD = day of a Julian month (01–31) T indicates the start of time information in the ODL ASCII time code format hh = hours (00–23) mm = minutes (00–59) ss = seconds (00–59) Z indicates "Zulu" time (same as GMT)	The LPS system date and time when the metadata file for a Level 0Ra file set was created. For ease of human readability, this date and time information is presented in the ODL ASCII format. The time is expressed as Universal Coordinated Time (also known as Greenwich Mean Time (GMT)). Insertion of additional characters "T" and "Z" is required to meet the ODL ASCII time format.
FILE_ VERSION_NO	1	= 0–9 where FILE_VERSION_NO = 0 indicates "not a reprocessed file" FILE_VERSION_NO =	Reprocessing indicator to distinguish this file from the metadata file generated earlier for the same subinterval and provided to the LPS to the LAM. The reprocessing information is entered/supplied by an operator during setup of the Level

		1–9 indicates the file reprocess count. The one digit LPS File Version number is also used in the FILE_NAME.	0Ra processing operations.
STATION_ID	3	= SSS where SSS indicates a three character ground station code. If data is received on tape from an IGS station, then the IGS station ID is used. See the L7 to IGS ICD for the full set of IGS stations.	A parameter retrieved from the Landsat 7 Raw CC filename.
SOFTWARE_ VERSION_NO	5	= "X.Y.Z" where X is the major release number Y is the minor release number Z is the patch (or engineering) release number X, Y, Z are all numeric values	Version number of the software installed on the LPS string when a metadata and its associated Level 0Ra files were generated.
L7_CPF_NAME	25	="L7CPFyyyymmdd_yyyymmdd.nn" where yyyymmdd = effective_date_begin and effective_date_end respectively nn = incrementing number for within a quarter (00-99)	The name of the Landsat 7 Calibration Parameter file (CPF) received from IAS and used in generating the Level 0Ra files identified in this metadata file. 00 is only valid for the prelaunch CPF.
END_GROUP	18	= METADATA_FILE_INFO	End of the second level ODL group. It indicates the end of the LPS Metadata File information Group records.
GROUP	26	= SUBINTERVAL_METADATA_ FMT_m where m = 1 for Format 1 OR m = 2 for Format 2	Beginning of the second level ODL group. It indicates the start of the ETM+ Format 1 or Format 2 subinterval level Metadata group records.

SPACECRAFT_ ID	8	= "Landsat7"	
SENSOR_ID	4	= "ETM+"	
CONTACT_ PERIOD_START _TIME	18	YYYY-DOYTHH:MM:SSZ Where YYYY = four-digit Julian year DOY = Julian day of year (001–366) T indicates the start of time information in the ODL ASCII time code format HH = hour of day (00–23) MM = minutes (00–59) SS = seconds (00–59) Z indicates "Zulu" time (same as GMT)	The Julian date and GMT when the Landsat 7 capture started. Insertion of additional characters "T" and "Z" is required to meet the ODL ASCII time format.
CONTACT_ PERIOD_STOP_ TIME	18	YYYY-DOYTHH:MM:SSZ (See above: CONTACT_PERIOD_START_TIME)	The Julian date and GMT when a Landsat 7 capture started + 1 hour. Prior to LPS release 6.1.1 the contact stop time was the actual stop time.
STARTING_ PATH	3	= 001–233 (leading 0s are required)	The starting WRS path number for the scenes included in this subinterval.
STARTING_ ROW	3	= 001–248 (leading 0s are required)	The starting WRS row number for the scene data included in this subinterval.
ENDING_ROW	3	= 001–248 (leading 0s are required)	The ending WRS row number for the scene data included in this subinterval.
LANDSAT_ INTERVAL_ID	24	= "MMSPPPRRRRRRYYYYDOYGSIVV" where MM = Sensor (LE = ETM+), S = Satellite (7), PPP = Start Path (L7 ETM+ = WRS-2 (001-233)), RRR = Start Row (001-248), RRR = End Row (001-248), YYYY = Year (1972-9999), DOY = Day of Year (001-366), GSI = Ground Station Identifier (AGS, ASN, EDC, SGS, XXX = unknown), VV =	A unique subinterval ID used for Landsat data consistency and tracking. Implemented with LPS release 7.1.0.

		Version (00-99)	
SUBINTERVAL_START_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where YYYY = four-digit Julian year, ddd = day (001–366*), 'T' indicates the start of time information in the ODL ASCII time code format hh = hours (00–23), mm = minutes (00–59), ss = seconds (00–59), tttttt = fractional seconds (0–9999375, where the clock cycle is 1/16 millisecond), 'Z' indicates "Zulu" time (same as GMT). * For cases when active imaging occurs at the end of a leap year.	The spacecraft time extracted from the timecode minor frames of the first ETM+ major frame of the subinterval reported in this file. A computed start time is provided if the timecode in the first ETM+ major frame is in error. Note: The year information (Capitalized) is appended by LPS to the spacecraft timecode. Insertion of additional characters "T" and "Z" is required to meet the ODL ASCII time format.
SUBINTERVAL_STOP_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_START_TIME, above.	The spacecraft time extracted from the timecode minor frames of the last ETM+ major frame of the subinterval reported in this file. Note: The year information (Capitalized) is appended by LPS to the spacecraft timecode.
TOTAL_ETM_SCANS	1–5	= N–11725 where N is an LPS operator selectable parameter value for the smallest subinterval that can be generated. The default value of N is 200.	The total number of ETM+ scans reported in this subinterval file. A maximum of 11,725 scans can be received in a 14-minute subinterval (based on a maximum of 35 full scenes, each consisting of at most 335 scans)
PCD_START_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_START_TIME, above.	Spacecraft time of the first PCD major frame in the PCD file associated with this subinterval.
PCD_STOP_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the	Spacecraft time of the last PCD major frame in the PCD file associated with this subinterval.

		same as for SUBINTERVAL_START_TIME, above.	
TOTAL_PCD_ MAJOR_ FRAMES	1–3	= 0–255	The total number of PCD major frames received in the PCD file associated with this subinterval. Approximately 212 major frames can be received by the LPS during a 14-minute subinterval.
SUBINTERVAL_ UL_CORNER_ LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	LPS calculated "actual" latitude value for the upper left corner of the subinterval. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_ UL_CORNER_ LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	LPS calculated "actual" longitude value for the upper left corner of the subinterval. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_ UR_CORNER_ L AT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	LPS calculated "actual" latitude value for the upper right corner of the subinterval. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_UR_CORNER_ LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	LPS calculated "actual" longitude value for the upper right corner of the subinterval. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_	8	= -90.0000 through	LPS calculated "actual" latitude value

LL_CORNER_ LAT		+90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	for the lower left corner of the subinterval. A subinterval may end at the last actual scan (not filled) in a partial scene.
SUBINTERVAL_ LL_CORNER_ LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	LPS calculated "actual" longitude value for the lower left corner of the subinterval. A subinterval may end at the last actual scan (not filled) in a partial scene.
SUBINTERVAL_ LR_CORNER_ LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	LPS calculated "actual" latitude value for the lower right corner of the subinterval. A subinterval may end at the last actual scan (not filled) in a partial scene.
SUBINTERVAL_ LR_CORNER_ LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	LPS calculated "actual" longitude value for the lower right corner of the subinterval. A subinterval may end at the last actual scan (not filled) in a partial scene.
ETM_LAST_ON _TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_STAR T_TIME, above.	See the Landsat 7 Wideband Data DFCB for details on this time.
ETM_LAST_ OFF_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where	See description, above, for ETM+_LAST_ON_TIME.

		the time format is the same as for SUBINTERVAL_START_TIME, above.	
UT1_ CORRECTION	8	= -0.90000 to +0.90000 seconds This time could be as large as 0.9 seconds in increments of fractions of seconds.	The UTC-UT1 time difference in seconds obtained from the Landsat 7 Calibration Parameter file received from IAS.
BAND1_ PRESENT	1	= "Y" indicates that Band 1 is present in this subinterval OR = "N" indicates that Band 1 is not present in this subinterval OR = "" , i.e. , a quote followed by a quote, indicates data corruption in PCD major frame. This field is included in the ETM+ Format 1 metadata only.	This is the "Band 1 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 0, where a bit set condition. (=1) indicates "Band 1 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND2_ PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	This is the "Band 2 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 1, where a bit set condition (=1) indicates "Band 2 ON state." The first error-free PCD major frame (2) is used to derive this value.
BAND3_ PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	This is the "Band 3 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 2, where a bit set condition (=1) indicates "Band 3 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND4_ PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in	This is the "Band 4 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 3, where a bit set condition (=1) indicates "Band 4

		the ETM+ Format 1 metadata only.	ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND5_ PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	This is the "Band 5 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 4, where a bit set condition (=1) indicates "Band 5 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND6_ PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 or Format 2 metadata.	This is the "Band 6/MIR ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 5, where a bit set condition (=1) indicates "Band 6 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND7_ PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 2 metadata only.	This is the "Band 7 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 6, where a bit set condition (=1) indicates "Band 7 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND8_ PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 2 metadata only.	This is the "Band 8 ON" status information obtained from PCD Serial Word "E" (major frame (2), minor frame 35, word 72), bit 0, where a bit set condition (=1) indicates "Band 8 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
TOTAL_WRS_ SCENES	1–2	= 0–99 This field is included in both ETM+ Format 1 and 2 metadata. Note: The LPS produces this count from the total number of WRS scenes	This count indicates the total number of WRS scenes identified by LPS in a subinterval. LPS may receive a maximum of 35 full WRS scenes, plus partial scenes at the start and/or the end of a subinterval, in a 14-minute subinterval. This count also indicates the total number of multiband scene browse files, for full and partial scenes, that may be produced by LPS

		identified in a subinterval. The LPS does not use the absolute difference between STARTING_ROW and ENDING_ROW to compute this +1 count.	and reported in the scene metadata.
PARTIAL_WRS_ SCENES	1	= 0–2 This field is included in both ETM+ Format 1 and 2 metadata.	Indicates the count of partial scenes, if any, at the start and/or at the end of a subinterval.
TOTAL_FILES	1–2	= 10–47 (Format 1 with up to 37 multiband browse scene files) OR = 6--9 (Format 2 with up to 3 Band 8 file segments)	The total number of LPS files included in this subinterval for ETM+ Format 1 or Format 2. Assuming that a subinterval contains at least one scene, the metadata file will contain the names of a minimum of 10 files (6 Band, 1 MSCD, 1 PCD, 1 Calibration and 1 Multiband scene browse Files) for Format 1, and 6 files (3 band, 1 MSCD, 1 PCD, and 1 Calibration files) for Format 2, respectively. A maximum of 35 full multiband scene browse files are provided for Format 1 subinterval only.
BAND1_FILE_ NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 2.4 for details on the file naming convention.) For the Band 1 file name: xxx = B10 (Format 1 only)	This file name is included in a Format 1 metadata file only.
BAND2_FILE_ NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 2.4 for details on the file naming convention.) For the Band 2 file name: xxx = B20 (Format 1 only)	This file name is included in a Format 1 metadata file only.
BAND3_FILE_ NAME	22	= "L7XsssfnYYDOYHHu	This file name is included in a Format 1 metadata file only.

		uv.xxx" (See Section 2.4 for details on the file naming convention.) For the Band 3 file name: xxx = B30 (Format 1 only)	
BAND4_FILE_ NAME	22	= "L7XsssfnYYDOYHHu uv.xxx" (See Section 2.4 for details on the file naming convention.) For the Band 4 file name: xxx = B40 (Format 1 only)	This file name is included in a Format 1 metadata file only.
BAND5_FILE_ NAME	22	= "L7XsssfnYYDOYHHu uv.xxx" (See Section 2.4 for details on the file naming convention.) For the Band 5 file name: xxx = B50 (Format 1 only)	This file name is included in a Format 1 metadata file only.
BAND6_FILE_ NAME	22	= "L7XsssfnYYDOYHHu uv.xxx" (See Section 2.4 for details on the file naming convention.) For the Band 6 file name: xxx = B60 (Format 1 or Format 2)	This file name is included in a Format 1 or Format 2 metadata file.
BAND7_FILE_ NAME	22	= "L7XsssfnYYDOYHHu uv.xxx" (See Section 2.4 for details on the file naming convention.)	This file name is included in a Format 2 metadata file only.

		For the Band 7 file name: xxx = B70 (Format 2 only)	
BAND8_FILE1_ NAME	22	= "L7XsssfnYYDOYHHu uv.xxx" (See Section 2.4 for details on the file naming convention.) For the Band 8, Segment 1 file name: xxx = B81 (Format 2 only)	This Band 8 file segment name is included in a Format 2 metadata file only. Up to three Band 8 file segments, each up to 2 GB long, are expected in a Format 2 subinterval.
BAND8_FILE2_ NAME	22	= "L7XsssfnYYDOYHHu uv.xxx" (See Section 2.4 for details on the file naming convention.) For the Band 8, Segment 2 file name: xxx = B82 (Format 2 only)	The name of this Band 8 file segment, if it exists in a subinterval, is included in a Format 2 metadata file only.
BAND8_FILE3_ NAME	22	= "L7XsssfnYYDOYHHu uv.xxx" (See Section 2.4 for details on the file naming convention.) For the Band 8, Segment 3 file name: xxx = B83 (Format 2 only)	The name of this Band 8 file segment, if it exists in a subinterval, is included in a Format 2 metadata file only.
MSCD_FILE_ NAME	22	= "L7XsssfnYYDOYHHu uv.xxx" (See Section 2.4 for details)xxx = MSD for an MSCD file	Name of the Mirror Scan Correction Data (MSCD) file associated with this subinterval.
PCD_FILE_ NAME	22	= "L7XsssfnYYDOYHHu uv.xxx"	Name of the Payload Correction Data (PCD) file associated with this subinterval.

		(See Section 2.4) xxx = PCD for a PCD file	
CAL_FILE_ NAME	22	= "L7XsssfnYYDOYHHu uv.xxx" (See Section 2.4) xxx = CAL for a Calibration file	Name of the Calibration file associated with this subinterval.
Scene Level Metadata (not an LPS metadata parameter)			The following parameters values are repeated for each ETM+ Format 1 or Format 2 scenes included in a subinterval.
GROUP	17	= METADATA _SCENE_NN where NN = 01–99 (Up to 35 full scenes are expected in a 14-minute subinterval)	Beginning of the second level ODL group. It indicates the beginning of the ETM+ Format 1 or Format 2 Scene NN level Metadata group records.
GROUP	12	= WRS_SCENE_NN where NN = 01–99	Beginning of the third level ODL group. It indicates the beginning of the ETM+ Format 1 or Format 2 WRS Scene 1 Metadata group records.
Scene Level Metadata (not an LPS metadata parameter)			The following parameters values are repeated for each WRS scene included in the subinterval.
WRS_SCENE_ NO	1–2	= 1–99	This is the LPS assigned WRS scene number within a subinterval.
FULL_OR_ PARTIAL_ SCENE	1	= "F" or "P" where F indicates a full WRS scene OR P indicates a partial WRS scene at the start or end of a subinterval.	The LPS may receive partial WRS scenes at the start and/or the end of a subinterval.
BROWSE_FILE_N AME	22	= "L7XsssfnYYDOYHHu uv.xxx" for a Format 1 subinterval (See Section 2.4) OR No browse file names are provided if it's a	The LPS generates Multiband Scene Browse files for ETM+ Format 1 (Bands 1–6) only. The names of all Multiband Scene Browse files, generated for a Format 1 subinterval, are provided with and reported in the Format 1 metadata. A maximum of 35 full WRS scenes are possible in a

		Format 2 subinterval. xxx = Rnn where R indicates a Multiband scene browse file, and nn = 00–99 indicates the Multiband Scene Browse file number within a subinterval.	subinterval.
WRS_PATH	3	= 001–233 (leading zeros are required)	The WRS path number associated with the scene from PCD scene accounting.
WRS_ROW	3	= 001–248 (leading zeros are required)	The WRS row number associated with the scene
LANDSAT_ SCENE_ID	21	= "MMSPPPRRRYYYYD OYGSIVV" where MM = Sensor (LE = ETM+) S = Satellite (7) PPP = Path (L7 ETM+ = WRS-2 (001-233)) RRR = Row (001-248) YYYY = Year (1972-9999) DOY = Day of Year (001-366) GSI = Ground Station Identifier (AGS, ASN, EDC, SGS, XXX = unknown) VV = Version (00-99)	A unique scene ID used for Landsat data consistency and tracking. Implemented with LPS release 7.1.0.
SCENE_ CENTER_SCAN_ NO	2–5	= 1–11725 (for "actual" scene centers in the subinterval.) For a partial scene with less than a half scene length data, the scene center scan number may be outside the actual subinterval band data range. It will be pointed to the non-existent scan 0 in the band file.	The ETM+ scan number nearest the calculated (actual) center of a WRS scene. A WRS scene scan number within a 14-minute subinterval can be as high as 11,725.

SCENE_ CENTER_SCAN _TIME	26	= YYYY-dddThh:mm:ss.tttttttZ where the time format is the same as for SUBINTERVAL_STAR T_TIME, above.	The spacecraft time associated with a WRS scene center scan (number).
SCENE_ CENTER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	WRS Scene Center Latitude - LPS calculated coordinate value. The computed "actual" scene centers for full and greater than half a scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the band file. The computed "actual" scene centers for smaller than half a scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the band file.
SCENE_ CENTER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	WRS Scene Center Longitude - LPS calculated coordinate value. The computed "actual" scene centers for full and greater than half a scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the band file. The computed "actual" scene centers for less than half a scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the band file.
HORIZONTAL_ DISPLAY_SHIFT	2–6	= - 99999 through + 99999 meters A negative (-) value defines a shift of the calculated "true" WRS scene center to the West of the nominal WRS scene center. A positive (+) value defines a shift of the	The horizontal distance between the perpendiculars through the LPS calculated "true" WRS Scene Center and the nominal (known) WRS scene center on ground. The LPS will maintain a lookup table of nominal WRS scene centers for computing the HORIZONTAL_DISPLAY_SHIFT (HDS) values for WRS scenes. The nominal valid maximum magnitude should be approximately 95000 meters.

		calculated "true" WRS scene center to the EAST of the nominal WRS scene center. Any HDS computed from poor ephemeris values which are larger than the maximum values will result in the maximum values (-99999 or +99999)	
SCENE_UL_ CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	WRS scene upper left corner "actual" latitude for a full or a partial scene.
SCENE_UL_ CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	WRS scene upper left corner "actual" longitude for a full or a partial scene.
SCENE_UR_ CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	WRS scene upper right corner "actual" latitude for a full or a partial scene.
SCENE_UR_ CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+)	WRS scene upper right corner "actual" longitude for a full or a partial scene.

		indicates East longitude. A negative (-) value indicates West longitude.	
SCENE_LL_ CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	WRS scene lower left corner "actual" latitude at for a full or a partial scene.
SCENE_LL_ CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	WRS scene lower left corner "actual" longitude at for a full or a partial scene.
SCENE_LR_ CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	WRS scene lower right corner "actual" latitude at for a full or a partial scene.
SCENE_LR_ CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value	WRS scene lower right corner "actual" longitude at for a full or a partial scene.

		indicates West longitude.	
SCENE_CCA	1–3	= 0–100 This field is included in the ETM+ Format 1 metadata only.	WRS scene cloud cover assessment (CCA) - Indicates the percent of a WRS scene area covered with clouds. This CCA is an average of the CCAs for all quadrants of the WRS scene.
UL_QUAD_CCA	1–3	= 0–100 This field is included in the ETM+ Format 1 metadata only.	Indicates the percent of upper left quadrant of the WRS scene area covered with clouds. For partial scenes, the quadrant score is for the quadrant of the actual data and not for what would be a full WRS scene.
UR_QUAD_CCA	1–3	= 0–100 This field is included in the ETM+ Format 1 metadata only.	Indicates the percent of upper right quadrant of the WRS scene area covered with clouds. For partial scenes, the quadrant score is for the quadrant of the actual data and not for what would be a full WRS scene.
LL_QUAD_CCA	1–3	= 0–100 This field is included in the ETM+ Format 1 metadata only.	Indicates the percent of lower left quadrant of the WRS scene area covered with clouds. For partial scenes, the quadrant score is for the quadrant of the actual data and not for what would be a full WRS scene.
LR_QUAD_CCA	1–3	= 0–100 This field is included in the ETM+ Format 1 metadata only.	Indicates the percent of lower right quadrant of the WRS scene area covered with clouds. For partial scenes, the quadrant score is for the quadrant of the actual data and not for what would be a full WRS scene.
ACCA_ ALGORITHM_ ID_VER	22	= 22 ASCII characters The Landsat 7 Project determines the algorithm name and version numbers. This field is included in the ETM+ Format 1 metadata only.	Identifies the ACCA algorithm (name and version number), used by LPS in calculating the automated cloud cover assessment for this scene.
SUN_AZIMUTH_A NGLE	12	= -180.0000000 through +180.0000000 degrees (with 7-digit precision) A positive value (+) indicates angles to the East or clockwise from North.	The Sun azimuth angle at the "true" WRS scene center (LPS calculated from PCD processing).

		A negative value (-) indicates angles to the West or counterclockwise from North. (Leading zeros are not required)	
SUN_ ELEVATION_ ANGLE	11	= -90.0000000 through +90.0000000 degrees (with 7-digit precision) A positive value (+) indicates a daytime scene. A negative value (-) indicates a nighttime scene.(Leading zeros are not required)	The Sun elevation angle at the "true" WRS scene center (LPS calculated from PCD processing).
SCENE_BAND1 _PRESENT	1	= "Y" indicates that Band 1 is present OR = "N" indicates that Band 1 is not present = "U" indicates that Band 1 presence is unknown This field is included in the ETM+ Format 1 metadata only.	This is the "Band 1 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 0, where a bit set condition. (=1) indicates "Band 1 ON state." The first error-free PCD major frame (2) associated with the scene is used to derive this value. If no valid PCD major frame falls within the scene's time boundary, then the value for the previous scene will be used. If the previous scene has no valid major frame (e.g., the first partial scene in a subinterval), then the value "U" for unknown will be used.
SCENE_BAND2 _PRESENT	1	(Same as SCENE_BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	Same as above with exception as noted. This is the "Band 2 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 1, where a bit set condition (=1) indicates "Band 2 ON state."
SCENE_BAND3_ PRESENT	1	(Same as SCENE_BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	Same as above with exception as noted. This is the "Band 3 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 2, where a bit set condition (=1) indicates "Band 3 ON state."

SCENE_BAND4_ PRESENT	1	(Same as SCENE_BAND1_PRE SENT values and format). This field is included in the ETM+ Format 1 metadata only.	Same as above with exception as noted. This is the "Band 4 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 3, where a bit set condition (=1) indicates "Band 4 ON state."
SCENE_BAND5_ PRESENT	1	(Same as SCENE_BAND1_PRE SENT values and format). This field is included in the ETM+ Format 1 metadata only.	Same as above with exception as noted. This is the "Band 5 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 4, where a bit set condition (=1) indicates "Band 5 ON state."
SCENE_BAND6_ PRESENT	1	(Same as SCENE_BAND1_PRE SENT values and format). This field is included in the ETM+ Format 1 or Format 2 metadata.	Same as above with exception as noted. This is the "Band 6/MIR ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 5, where a bit set condition (=1) indicates "Band 6 ON state."
SCENE_BAND7_ PRESENT	1	(Same as SCENE_BAND1_PRE SENT values and format). This field is included in the ETM+ Format 2 metadata only.	Same as above with exception as noted. This is the "Band 7 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 6, where a bit set condition (=1) indicates "Band 7 ON state."
SCENE_BAND8_ PRESENT	1	(Same as SCENE_BAND1_PRE SENT values and format). This field is included in the ETM+ Format 2 metadata only.	Same as above with exception as noted. This is the "Band 8 ON" status information obtained from PCD Serial Word "E" (major frame (2), minor frame 35, word 72), bit 0, where a bit set condition (=1) indicates "Band 8 ON state."
BAND1_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 metadata only.	The band gain condition detected at the start of a WRS scene. This information is obtained from Words 7 and 8 of the PCD/Status Data field of the first error-free VCDU in a WRS scene.
BAND2_GAIN	1	= "L" for a low gain	(See parameter description for

		condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 metadata only.	BAND1_GAIN)
BAND3_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN)
BAND4_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN)
BAND5_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN)
BAND6_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 or Format 2 metadata.	(See parameter description for BAND1_GAIN)
BAND7_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition	(See parameter description for BAND1_GAIN)

		This field is included in the ETM+ Format 2 metadata only.	
BAND8_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 2 metadata only.	(See parameter description for BAND1_GAIN)
BAND1_GAIN_ CHANGE	1	= "0" indicates no band gain change within scene or = "+" indicates a low to high band gain change within scene or = "-" indicates a high to low band gain change within scene This field is included in the ETM+ Format 1 metadata only.	LPS generates band gain change flags by evaluating corresponding band gain states in adjacent ETM+ scans (major frames).
BAND2_GAIN_ CHANGE	1	(Same as for BAND1_GAIN_CHAN GE)This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN_CHANGE)
BAND3_GAIN_ CHANGE	1	(Same as for BAND1_GAIN_CHAN GE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN_CHANGE)
BAND4_GAIN_ CHANGE	1	(Same as for BAND1_GAIN_CHAN GE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN_CHANGE)
BAND5_GAIN_ CHANGE	1	(Same as for BAND1_GAIN_CHAN GE)	(See parameter description for BAND1_GAIN_CHANGE)

		This field is included in the ETM+ Format 1 metadata only.	
BAND6_GAIN_ CHANGE	1	(Same as for BAND1_GAIN_CHAN GE) This field is included in the ETM+ Format 1 or Format 2 metadata.	(See parameter description for BAND1_GAIN_CHANGE)
BAND7_GAIN_ CHANGE	1	(Same as for BAND1_GAIN_CHAN GE) This field is included in the ETM+ Format 2 metadata only.	(See parameter description for BAND1_GAIN_CHANGE)
BAND8_GAIN_ CHANGE	1	(Same as for BAND1_GAIN_CHAN GE) This field is included in the ETM+ Format 2 metadata only.	(See parameter description for BAND1_GAIN_CHANGE)
BAND1_SL_ GAIN_CHANGE	1-5	= NNNNN where 0 = no gain change 1--12000 = the scan line number where the first change in band gain was detected, but physical change occurred in the previous scan. This field is included in the ETM+ Format 1 metadata only.	This field indicates the scan line number in the scene for the first change detected in the band gain condition. The gain state change was detected at the scan line number indicated, but the physical change occurred in the previous scan.
BAND2_SL_ GAIN_CHANGE	1-5	(Same as for BAND1_SL_GAIN_CH ANGE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_SL_GAIN_CHANGE)
BAND3_SL_ GAIN_CHANGE	1-5	(Same as for BAND1_SL_GAIN_CH ANGE) This field is included in	(See parameter description for BAND1_SL_GAIN_CHANGE)

		the ETM+ Format 1 metadata only.	
BAND4_SL_ GAIN_CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_SL_GAIN_CHANGE)
BAND5_SL_ GAIN_CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_SL_GAIN_CHANGE)
BAND6_SL_ GAIN_CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 1 or Format 2 metadata.	(See parameter description for BAND1_SL_GAIN_CHANGE)
BAND7_SL_ GAIN_CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 2 metadata only.	(See parameter description for BAND1_SL_GAIN_CHANGE)
BAND8_SL_ GAIN_CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 2 metadata only.	(See parameter description for BAND1_SL_GAIN_CHANGE)
FULL_ APERTURE_ CAL_FLAG	1	= "N" indicates no full calibration activity during this scene OR = "Y" indicates a full calibration activity	This field indicates the ETM+ full calibration activity during this scene. The calibration door activity flag is interpolated from "serial word P" of the third PCD major frame, minor frame 84, word 72, bits 2 and 3.
DAY_NIGHT_ FLAG	1	= "D" for day flag 'True' OR = "N" for night flag 'True'	This field indicates the day or night condition for the scene. The LPS determines the day/night condition of a scene by comparing the Sun elevation values against an angle value of 0 degrees. A scene is declared a day scene if the Sun

			elevation angle is greater than 0 degrees; otherwise it is declared a night scene.
END_GROUP	12	= WRS_SCENE_NN where NN = 01–99 (Up to 35 full scenes are expected to be received by LPS in a 14-minute subinterval)	End of the third level ODL group. It indicates the end of the ETM+ Format 1 or Format 2 WRS Scene Metadata group records.
Image Q&A Data(not an LPS metadata parameter)			The following parameter values are repeated for each WRS scene included in this subinterval.
GROUP	9	= ETM_QA_NN where NN = 01–99	Beginning of the third level ODL group. It indicates the beginning of the ETM+ Format 1 or Format 2 Scene NN Q&A data group records.
SCENE_ QUALITY	2	= 00-99 OR = -1 if the scene quality is not calculated	A scene quality score as described in Section 3.2.2 with the first digit representing image quality and the second digit representing PCD quality. 99 represents highest quality and 00 is the worst quality score for a scene. The -1 will not be used by LPS and is specified here to be consistent with the L7 to IGS ICD.
CADUS_VCDUS_ RECEIVED	1–6	= 1–999999	The total number of CADUs/VCDUs received for this scene. Approximately 362,380 VCDUs are expected to be received for a 26.8-second long WRS scene. A WRS scene consists of a maximum of 375, including 40 overlap scans.
FLY_WHEEL_ CADUS	1–6	= 0–999999	The total number of CADUs fly-wheeled due to sync errors.
CADUS_SYNC_ ERR	1–6	= 0–999999	The total number of CADUs with sync errors.
CADUS_ MISSING	1–6	= 0–999999	The total number of missing CADUs.
RS_ERR_ VCDUS	1–6	= 0–999999	The total number of VCDUs with Reed-Solomon error corrected in the header field.
BCH_ CORRECTED_V CDUS	1–6	= 0–999999	The total number of VCDUs with BCH errors corrected for up to 3 bits in their mission data fields.
BCH_ UNCORRECTED_ VCDUS	1–6	= 0–999999	The total number of VCDUs containing uncorrected BCH errors (bits) in their mission data fields.
BCH_	1–6	= 0–999999	The total number of BCH corrected

CORRECTED_ BITS			bits in the mission data zone.
BIT_ERROR_ RATE	1–4	= 0–9999	The number of bit errors detected over the whole length of the scene and normalized to average number of errors in 100,000 bits. BIT_ERROR_RATE = (Total Detected Bit Errors/Total Number of Bits in Subinterval) x 100,000. This BER is calculated using bit errors detected (corrected or not) during BCH checks of the input VCDUs. An input data bit error rate of 1 in 100,000 or less is considered acceptable.
ETM_TIMECODE_ ERRORS	1–3	= 0--375	The total number of ETM+ scans (major frames) detected with errors in their time code fields during processing of this subinterval scene. A maximum of 375 ETM+ scans are possible in a WRS scene.
ENTIRELY_ FILLED_SCANS	1–3	= 0–375	The total number of ETM+ major frames (maximum of 375) in this WRS scene (~26.8 seconds for 375 scans) that were entirely filled using a predetermined fill data pattern.
PARTIALLY_ FILLED_SCANS	1–3	= 0–375	The total number of ETM+ major frames (maximum of 375) in this WRS scene that were partially filled using a predetermined fill data pattern.
END_GROUP	9	= ETM_QA_NN where NN = 01–99	End of the third level ODL group. It indicates the end of the ETM+ Q&A data group records for WRS Scene NN.
PCD Q&A Data (not an LPS metadata parameter)			The following parameter values are repeated for each WRS scene included in the subinterval.
GROUP	9	= PCD_QA_NN where NN = 01–99	Beginning of the third level ODL group. It indicates the beginning of the PCD Q&A data group records for WRS Scene NN.
PCD_WORDS_ RECEIVED	1–6	= 0–999999	The total number of PCD words, extracted from the unpacked PCD words (one sync byte, 3 repeated data bytes, and at least 4 fill bytes), received for this scene. LPS can receive approximately 107,200 packed PCD words for a 26.8-second scene.
PCD_BYTE_	1–6	= 0–999999	The total number of PCD words that

VOTING_ERR			encountered byte-voting errors during packing (for a maximum of 107,200 words).
TOTAL_PCD_ MINOR_FRAMES	1–3	= 0–999	The total number of PCD minor frames constructed during this scene. LPS can receive approximately 838 PCD minor frames for a 26.8- second WRS scene.
PCD_MINOR_ FRAME_ERR	1–3	= 0–999	The total number of PCD minor frames which encountered sync errors during their construction for a scene. Up to 838 minor frames for a WRS scene are expected.
FILLED_PCD_ MINOR_FRAMES	1–3	= 0–999	The total number of PCD minor frames which required a data fill during their construction.
FILLED_PCD_ MAJOR_FRAMES	1	= 0–9	The total number of PCD major frames which required a data fill during their construction. LPS can receive approximately 7 major frames for a 26.8-second long WRS scene.
END_GROUP	9	= PCD_QA_NN where NN = 01–99	End of the third level ODL group. It indicates the end of the PCD Q&A data group records for WRS Scene NN.
Processed PCD Q&A Data (not an LPS metadata parameter)			The following parameter values are repeated for each WRS scene included in the subinterval.
GROUP	19	= PROCESSED_PCD_Q A_NN where NN = 01–99	Beginning of the third level ODL group. It indicates the beginning of the processed PCD Q&A data group records for WRS Scene NN.
TOTAL_ ATTITUDE_ POINTS	1	= 0–9	The total number of spacecraft attitude data points (quaternations) received and processed from the PCD associated with this scene. Approximately 6.5 spacecraft attitude data points can be received for a 26.8-second WRS scene.
REJECTED_ ATTITUDE_ POINTS	1	= 0–9	The total number of spacecraft attitude data points (quaternations) found to fail the PCD quality checks. The rejected data points are flagged and included in the PCD file associated with this WRS scene.
MISSING_ ATTITUDE_ POINTS	1	= 0–9	The total number of spacecraft attitude data points (quaternations) found missing during PCD quality

			checks. The missing data points are flagged and included in the PCD file associated with this WRS scene.
TOTAL_ EPHEMERIS_ POINTS	1	= 0–9	The total number of ephemeris data points received and processed from the PCD of this scene. Approximately 7 ephemeris data points can be received for a 26.8-second long WRS scene.
REJECTED_ EPHEMERIS_ POINTS	1	= 0–9	The total number of spacecraft ephemeris data points found to fail LPS PCD quality checks. The rejected data points are flagged and included in the PCD file associated with this WRS scene.
MISSING_ EPHEMERIS_ POINTS	1	= 0–9	The total number of spacecraft ephemeris data points found missing during PCD quality checks. The missing data points are flagged and included in the PCD file associated with this WRS scene.
END_GROUP	19	= PROCESSED_PCD_QA_NN where NN = 01–99	End of the third level ODL group. It indicates the end of the processed PCD Q&A data group records for WRS Scene NN.
END_GROUP	17	= METADATA _SCENE_NN where NN = 01–99 (Up to 35 full scenes are expected to be received by LPS in a 14-minute subinterval)	End of the second level ODL group. It indicates the end of the ETM+ Format 1 or Format 2 Scene NN level metadata group records.
END_GROUP	26	= SUBINTERVAL_METADATA_ FMT_m m = 1 for Format 1 OR m = 2 for Format 2	End of the second level ODL group. It indicates the end of the ETM+ Format 1 or Format 2 subinterval level Metadata group records.
END_GROUP	13	= METADATA_FILE	End of the first level ODL group. It indicates the end of the LPS Metadata File Level Group records for an ETM+ Format 1 or Format 2 subinterval.
END			End of Metadata file marker.

Table 3-19. Metadata File Format - ODL Parameter Values

3.2.2 Algorithm for Calculation of Scene Quality

The LPS use a two-digit number that separates image and PCD data quality for Landsat 7. The first digit represents image data quality and can range in value from 0 to 9. The second digit represents PCD quality and can range in value from 0 to 9. The formula for the combined score is:

image score * 10 + PCD score

The following paragraphs describe how the image quality and PCD quality scores are assigned.

3.2.2.1 Image Quality Component

The image quality digit is based on the number and distribution of bad scans or equivalent bad scans in a scene. The image quality digit is computed by dividing the total number of filled minor frames for a scene by 6313 (the nominal number of image data minor frames in a scan for 30 meter bands). This computation will give the number of equivalent bad scans. The number of scans where the EOL is not found is then added to this bad scan count.

The distribution of filled minor frames is characterized as being either clustered or scattered. A cluster of 128 bad scans will still yield a scene with a cluster of 246 good scans which is almost 2/3 of a scene. A scattering of 128 bad scans may make the entire image worthless.

What defines clustering versus scattering? It is determined that bad equivalent scans are clustered if they occur within a grouping of 128 contiguous scans (approximately 1/3 of a scene). Errors are characterized as scattered if they occur outside the bounds of 128 contiguous scans. The image score is assigned according to the rules in Table 3-20.

SCORE	IMAGE QUALITY
9	no errors detected, a perfect scene
8	≤ 4 equivalent bad scans, clustered
7	≤ 4 equivalent bad scans, scattered
6	≤ 16 equivalent bad scans, clustered
5	≤ 16 equivalent bad scans, scattered
4	≤ 64 equivalent bad scans, clustered
3	≤ 64 equivalent bad scans, scattered
2	≤ 128 equivalent bad scans, clustered
1	≤ 128 equivalent bad scans, scattered
0	> 128 equivalent bad scans, scattered (> 33% of the scene is bad)

Table 3-20. Scene Quality Score - Image Quality Component

3.2.2.2 PCD Quality Component

The PCD quality digit is based on the number and distribution of filled PCD minor frames. There are approximately 7 PCD major frames for a standard WRS scene

comprised of 375 scans. Each PCD major frame consists of 128 minor frames or 16,384 bytes. Clustering of filled PCD minor frames indicates that errors are localized whereas scattering indicates that numerous or all major frames may be affected.

What defines clustering versus scattering? Each PCD minor frame has 16 jitter measurements and corresponds to 30 milliseconds or approximately 1/2 of a scan. Two minor frames correspond to a single scan while 256 minor frames (i.e., 2 PCD major frames) correspond to 128 scans or approximately 1/3 of a scene.

Like the image data, it is determined that bad PCD minor frames are clustered if they occur within a grouping of 2 contiguous PCD major frames (1/3 of a scene). Errors are characterized as scattered if they occur outside the bounds of contiguous PCD major frames. The PCD score is assigned according to the rules in Table 3-21.

SCORE	PCD QUALITY
9	no PCD errors detected
8	≤ 8 bad minor frames, clustered
7	≤ 8 bad minor frames, scattered
6	≤ 32 bad minor frames, clustered
5	≤ 32 bad minor frames, scattered
4	≤ 128 bad minor frames, clustered
3	≤ 128 bad minor frames, scattered
2	≤ 256 bad minor frames, clustered
1	≤ 256 bad minor frames, scattered
0	> 256 bad minor frames, scattered (>33% of the scene is bad)

Table 3-21. Scene Quality Score - PCD Quality Component

3.2.2.3 Scene Quality

The score calculated using the methods described above is recorded in the scene level metadata under the keyword SCENE_QUALITY. Using this scoring system the highest possible rating for an image would be 99, the lowest 00. The score treats missing image data more critically than missing or filled PCD data. For example, an image with 16 filled scans that are scattered and with errorless PCD would have a 59 score whereas an image with intact image data and a 32 filled PCD minor frames that are scattered would receive a score of 95. The rationale is that PCD is less important because missing values can always be extrapolated or interpolated to enable level 1 processing. Missing image data cannot be retrieved and thus impacts the user more severely than missing PCD. The score construct unambiguously alerts the user to image data deterioration. The value of -1 is reserved for systems that do not calculate the scene quality. LPS will always calculate a scene quality value, but this is mentioned here to be consistent with the L7 to IGS ICD.

3.2.3 Metadata File Format – ODL Examples

The examples in the following sections illustrate the structure of the LPS metadata files. The values shown for the metadata parameters are in the ODL format. It should be noted that the values used in these examples might not be accurate because no attempt has been made to map them to the illustrated metadata subinterval and/or the WRS scene boundaries.

The ODL procedures are used to construct the subinterval, WRS scenes, and individual WRS scene metadata GROUPS. GROUP statements are presented in bold in this DFCB only. (Bold statements are not required in the metadata implementation.) In addition, the comment statements enclosed within "/*" and "*/" are shown to clarify the metadata format construction. They are not explicitly required in the implemented metadata file format.

3.2.3.1 ODL Examples – Format 1 Metadata File

```
/* LPS Level 0Ra subinterval Metadata file - Format 1 */

GROUP = METADATA_FILE

        /* Metadata file identification - Format 1 */

        GROUP = METADATA_FILE_INFO
        FILE_NAME = "L71EDC119813511010.MTA"
        FILE_CREATION_ DATE_TIME = 1998-05-15T13:30:25Z
        FILE_VERSION_NO = 0
        STATION_ID = "EDC"
        SOFTWARE_VERSION_NO = "2.1.0"
        L7_CPF_NAME = "L7CPF19981001_19981231.01"
        END_GROUP = METADATA_FILE_INFO

        /* Subinterval level metadata - Format 1 */

        GROUP = SUBINTERVAL_METADATA_FMT_1
        SPACECRAFT_ID = "Landsat7"
        SENSOR_ID = "ETM+"
        CONTACT_PERIOD_START_TIME = 1998-135T11:23:10Z
        CONTACT_PERIOD_STOP_TIME = 1998-135T11:37:01Z
        STARTING_PATH = 029
        STARTING_ROW = 020
        ENDING_ROW = 045
        LANDSAT_INTERVAL_ID = “LE70290200451998135EDC00”
        SUBINTERVAL_START_TIME = 1998-135T11:25:01.1234567Z
        SUBINTERVAL_STOP_TIME = 1998-135T11:35:05.7654321Z
        TOTAL_ETM_SCANS = 8853
        PCD_START_TIME = 1998-135T11:25:01.1234567Z
        PCD_STOP_TIME = 1998-135T11:35:05.7654321Z
```

```
TOTAL_ PCD_MAJOR_FRAMES = 147
SUBINTERVAL_UL_CORNER_LAT =   41.5432        /* Sample Results are */
SUBINTERVAL_UL_CORNER_LON = -96.5432         /* shown; not related*/
SUBINTERVAL_UR_CORNER_LAT =   41.4321        /*  to other results */
SUBINTERVAL_UR_CORNER_LON = -96.6543         /* included in this */
SUBINTERVAL_LL_CORNER_LAT = -96.6543         /* Example */
SUBINTERVAL_LL_CORNER_LON = -96.3543
SUBINTERVAL_LR_CORNER_LAT =   41.3432
SUBINTERVAL_LR_CORNER_LON = -96.6543
ETM_LAST_ON_TIME = 1998-135T11:20:01.1234567Z
ETM_LAST_OFF_TIME = 1998-135T09:25:01.7654321Z
UT1_CORRECTION = 0.12345
BAND1_PRESENT = "Y"
BAND2_PRESENT = "Y"
BAND3_PRESENT = "Y"
BAND4_PRESENT = "Y"
BAND5_PRESENT = "Y"
BAND6_PRESENT = "Y"
TOTAL_WRS_SCENES = 26
PARTIAL_WRS_SCENES = 2
TOTAL_FILES = 35
BAND1_FILE_NAME = "L71EDC119813511010.B10"
BAND2_FILE_NAME = "L71EDC119813511010.B20"
BAND3_FILE_NAME = "L71EDC119813511010.B30"
BAND4_FILE_NAME = "L71EDC119813511010.B40"
BAND5_FILE_NAME = "L71EDC119813511010.B50"
BAND6_FILE_NAME = "L71EDC119813511010.B60"
MSCD_FILE_NAME = "L71EDC119813511010.MSD"
PCD_FILE_NAME = "L71EDC119813511010.PCD"
CAL_FILE_NAME = "L71EDC119813511010.CAL"

/* Metadata for all WRS scenes included in the Format 1 subinterval */
/* Note:  The WRS scene centers correspond to Band 1 scan times */

GROUP = METADATA_SCENE_01
GROUP = WRS_SCENE_01
WRS_SCENE_NO = 1
FULL_OR_PARTIAL_SCENE = "P"
BROWSE_FILE_NAME = "L71EDC119813511010.R01"
WRS_PATH = 029
WRS_ROW = 020
LANDSAT_SCENE_ID = “LE70290201998135EDC00”
SCENE_CENTER_SCAN_NO = 95
SCENE_CENTER_SCAN_TIME = 1998-135T11:26:45.1234567Z
SCENE_CENTER_LAT =   42.1234
SCENE_CENTER_LON = -96.7654
```

```
HORIZONTAL_DISPLAY_SHIFT =  275
SCENE_UL_CORNER_LAT =   41.5432
SCENE_UL_CORNER_LON = -96.5432
SCENE_UR_CORNER_LAT =   41.4321
SCENE_UR_CORNER_LON = -96.6543
SCENE_LL_CORNER_LAT =   41.6543
SCENE_LL_CORNER_LON = -96.3543
SCENE_LR_CORNER_LAT =   41.3432
SCENE_LR_CORNER_LON = -96.6543
SCENE_CCA = 52
UL_QUAD_CCA = 99
UR_QUAD_CCA = 99
LL_QUAD_CCA = 4
LR_QUAD_CCA = 6
ACCA_ALGORITHM_ID_VER = "ACCA_11MAY98_9999E.ALG"
SUN_AZIMUTH_ANGLE = 20.1234567
SUN_ELEVATION_ANGLE = 20.1234567
SCENE_BAND1_PRESENT = "Y"
SCENE_BAND2_PRESENT = "Y"
SCENE_BAND3_PRESENT = "Y"
SCENE_BAND4_PRESENT = "Y"
SCENE_BAND5_PRESENT = "Y"
SCENE_BAND6_PRESENT = "Y"
BAND1_GAIN = "H"
BAND2_GAIN = "H"
BAND3_GAIN = "H"
BAND4_GAIN = "H"
BAND5_GAIN = "H"
BAND6_GAIN = "L"
BAND1_GAIN_CHANGE = "0"
BAND2_GAIN_CHANGE = "0"
BAND3_GAIN_CHANGE = "0"
BAND4_GAIN_CHANGE = "0"
BAND5_GAIN_CHANGE = "-"
BAND6_GAIN_CHANGE = "0"
BAND1_SL_GAIN_CHANGE = 0
BAND2_SL_GAIN_CHANGE = 0
BAND3_SL_GAIN_CHANGE = 0
BAND4_SL_GAIN_CHANGE = 0
BAND5_SL_GAIN_CHANGE = 9000
BAND6_SL_GAIN_CHANGE = 0
FULL_APERTURE_CAL_FLAG = "N"
DAY_NIGHT_FLAG = "D"
END_GROUP = WRS_SCENE_01
```

/* Scene image data quality and accounting (Q&A) data */

GROUP = ETM_QA_01
SCENE_QUALITY = 99
CADUS_VCDUS_RECEIVED = 543926
FLY_WHEEL_CADUS = 123456
CADUS_SYNC_ERR = 234567
CADUS_MISSING = 42
RS_ERR_VCDUS = 123
BCH_CORRECTED_VCDUS = 456
BCH_UNCORRECTED_VCDUS = 12
BCH_CORRECTED_BITS = 666
BIT_ERROR_RATE = 10
ETM_TIMECODE_ERRORS = 12
ENTIRELY_FILLED_SCANS = 12
PARTIALLY_FILLED_SCANS = 123
END_GROUP = ETM_QA_01

/* Scene PCD quality and accounting information */

GROUP = PCD_QA_01
PCD_WORDS_RECEIVED = 106340
PCD_BYTE_VOTING_ERR = 106
TOTAL_PCD_MINOR_FRAMES = 202
PCD_MINOR_FRAME_ERR = 202
FILLED_PCD_MINOR_FRAMES = 200
FILLED_PCD_MAJOR_FRAMES = 1
END_GROUP = PCD_QA_01

/* Processed PCD quality and accounting information on scene */

GROUP = PROCESSED_PCD_QA_01
TOTAL_ATTITUDE_POINTS = 6
REJECTED_ATTITUDE_POINTS = 1
MISSING_ATTITUDE_POINTS = 1
TOTAL_EPHEMERIS_POINTS = 6
REJECTED_EPHEMERIS_POINTS = 1
MISSING_EPHEMERIS_POINTS = 1
END_GROUP = PROCESSED_PCD_QA_01

END_GROUP = METADATA _SCENE_01

- /* Repeat METADATA _SCENE_NN until NN > 26, */
- /* the total number of WRS scenes, full or partial, present in this */
- /* subinterval example */

GROUP = METADATA_SCENE_NN

```
                    /* Scene NN Metadata ODL group */

        END_GROUP = METADATA_SCENE_NN

        END_GROUP = SUBINTERVAL_METADATA_FMT_1

        END_GROUP = METADATA_FILE

        END
```

3.2.3.2 ODL Example – Format 2 Metadata File

```
/* LPS Level 0Ra subinterval Metadata file - Format 2 */

GROUP = METADATA_FILE

        /* Metadata file identification - Format 2 */

        GROUP = METADATA_FILE_INFO
        FILE_NAME = "L71EDC229813511010.MTA"
        FILE__CREATION_ DATE_TIME = 1998-05-15T13:30:26Z
        FILE_VERSION_NO = 0
        STATION_ID = "EDC"
        SOFTWARE_VERSION_NO = "2.1.0"
        L7_CPF_NAME = "L7CPF19981001_19981231.01"
        END_GROUP = METADATA_FILE_INFO

        /* Subinterval level metadata - Format 2 */

        GROUP = SUBINTERVAL_METADATA_FMT_2
        SPACECRAFT_ID = "Landsat7"
        SENSOR_ID = "ETM+"
        CONTACT_PERIOD_START_TIME = 1998-135T11:23:10Z
        CONTACT_PERIOD_STOP_TIME = 1998-135T11:37:01Z
        STARTING_PATH = 029
        STARTING_ROW = 020
        ENDING_ROW = 045
        LANDSAT_INTERVAL_ID = “LE70290200451998135EDC00”
        SUBINTERVAL_START_TIME = 1998-135T11:25:01.1234567Z
        SUBINTERVAL_STOP_TIME = 1998-135T11:35:05.7654321Z
        TOTAL_ETM_SCANS = 8853
        PCD_START_TIME = 1998-135T11:25:01.1234567Z
        PCD_STOP_TIME = 1998-135T11:35:05.7654321Z
        TOTAL_ PCD_MAJOR_FRAMES = 147
        SUBINTERVAL_UL_CORNER_LAT =   41.5432  /* Sample Results are shown; */
```

SUBINTERVAL_UL_CORNER_LON = -96.5432 /* not related to other results */
SUBINTERVAL_UR_CORNER_LAT =   41.4321 /* included in this Example */
SUBINTERVAL_UR_CORNER_LON = -96.6543
SUBINTERVAL_LL_CORNER_LAT = -96.6543
SUBINTERVAL_LL_CORNER_LON = -96.3543
SUBINTERVAL_LR_CORNER_LAT =   41.3432
SUBINTERVAL_LR_CORNER_LON = -96.6543
ETM_LAST_ON_TIME = 1998-135T11:15:01.1234567Z
ETM_LAST_OFF_TIME = 1998-135T09:25:01.7654321Z
UT1_CORRECTION = 0.1234567
BAND6_PRESENT = "Y"
BAND7_PRESENT = "Y"
BAND8_PRESENT = "Y"
TOTAL_WRS_SCENES = 26
PARTIAL_WRS_SCENES = 2
TOTAL_FILES = 8
BAND6_FILE_NAME = "L71EDC219813511010.B60"
BAND7_FILE_NAME = "L71EDC219813511010.B70"
BAND8_FILE1_NAME = "L71EDC219813511010.B81"
BAND8_FILE2_NAME = "L71EDC219813511010.B82"
BAND8_FILE3_NAME = "L71EDC219813511010.B83"
MSCD_FILE_NAME = "L71EDC219813511010.MSD"
PCD_FILE_NAME = "L71EDC219813511010.PCD"
CAL_FILE_NAME = "L71EDC219813511010.CAL"

/* WRS scene-by-scene metadata for this Level 0Ra subinterval */
/* Note: The WRS scene centers correspond to Band 7 scan times */

GROUP = METADATA_SCENE_01

GROUP = WRS_SCENE_01
WRS_SCENE_NO = 1
FULL_OR_PARTIAL_SCENE = "P"
WRS_PATH = 029
WRS_ROW = 020
LANDSAT_SCENE_ID = “LE70290201998135EDC00”
SCENE_CENTER_SCAN_NO = 95
SCENE_CENTER_SCAN_TIME = 1998-135T11:26:45.1234567Z
SCENE_CENTER_LAT =   42.1234
SCENE_CENTER_LON = -96.7654
HORIZONTAL_DISPLAY_SHIFT = 275
SCENE_UL_CORNER_LAT =   41.5432
SCENE_UL_CORNER_LON = -96.5432
SCENE_UR_CORNER_LAT =   41.4321
SCENE_UR_CORNER_LON = -96.6543
SCENE_LL_CORNER_LAT =   41.6543

```
SCENE_LL_CORNER_LON = -96.3543
SCENE_LR_CORNER_LAT =   41.3434
SCENE_LR_CORNER_LON = -96.6543
SUN_AZIMUTH_ANGLE = 20.1234567
SUN_ELEVATION_ANGLE = 20.1234567
SCENE_BAND6_PRESENT = "Y"
SCENE_BAND7_PRESENT = "Y"
SCENE_BAND8_PRESENT = "Y"
BAND6_GAIN = "H"
BAND7_GAIN = "H"
BAND8_GAIN = "H"
BAND6_GAIN_CHANGE = "0"
BAND7_GAIN_CHANGE = "-"
BAND8_GAIN_CHANGE = "0"
BAND6_SL_GAIN_CHANGE = 0
BAND7_SL_GAIN_CHANGE = 9000
BAND8_SL_GAIN_CHANGE = 0
FULL_APERTURE_CAL_FLAG = "N"
DAY_NIGHT_FLAG: "D"
END_GROUP = WRS_SCENE_01

        /* Scene Image Data quality and accounting (Q&A) data */

GROUP = ETM_QA_01
SCENE_QUALITY = 99
CADUS_VCDUS_RECEIVED = 543926
FLY_WHEEL_CADUS = 123456
CADUS_SYNC_ERR = 234567
CADUS_MISSING = 42
RS_ERR_VCDUS = 123
BCH_CORRECTED_VCDUS = 456
BCH_UNCORRECTED_VCDUS = 12
BCH_CORRECTED_BITS = 666
BIT_ERROR_RATE = 99
ETM_TIMECODE_ERRORS = 12
ENTIRELY_FILLED_SCANS = 12
PARTIALLY_FILLED_SCANS = 123
END_GROUP = ETM_QA_01

        /* Scene PCD quality and accounting information */

GROUP = PCD_QA_01
PCD_WORDS_RECEIVED = 106341
PCD_BYTE_VOTING_ERR = 106
TOTAL_PCD_MINOR_FRAMES = 202
PCD_MINOR_FRAME_ERR = 202
```

FILLED_PCD_MINOR_FRAMES = 199
FILLED_PCD_MAJOR_FRAMES = 1
END_GROUP = PCD_QA_01

/* Processed PCD quality and accounting information on scene */

GROUP = PROCESSED_PCD_QA_01
TOTAL_ATTITUDE_POINTS = 6
REJECTED_ATTITUDE_POINTS = 1
MISSING_ATTITUDE_POINTS = 1
TOTAL_EPHEMERIS_POINTS = 6
REJECTED_EPHEMERIS_POINTS = 1
MISSING_EPHEMERIS_POINTS = 1
END_GROUP = PROCESSED_PCD_QA_01

END_GROUP = METADATA_SCENE_01

- /* Repeat METADATA_SCENE_NN GROUP until NN > 26, */
- /* the total number of WRS scenes, full or partial, present in this */
- /* subinterval example */

GROUP = METADATA _SCENE_NN

/* Scene NN Metadata ODL group */

END_GROUP = METADATA_SCENE_NN

END_GROUP = SUBINTERVAL_METADATA_FMT_2

END_GROUP = METADATA_FILE

END

3.3 Multiband Browse File Format (HDF RIS24)

The LPS produces a multiband scene browse for each of the WRS scenes identified during Level 0Ra processing of an ETM+ Format 1 subinterval. Each multiband scene browse is a reduced-size image produced from three predefined bands of a WRS scene received in an ETM+ Format 1 subinterval.

For SLC-on data, each LPS-produced multiband scene browse image is radiometrically corrected, reduced using the Wavelet algorithm, linear contrast stretched (only day scenes), compressed using HDF JPEG, and output in the HDF RIS24 file format for transfer to the LAM. For SLC-off data, each LPS-produced multiband scene browse image is radiometrically corrected and linear contrast stretched (only day scenes), an along-track linear adjustment is applied to each scan to show the scan gaps, then reduced using an averaging/sub-sampling algorithm in addition to the Wavelet

algorithm, compressed using HDF JPEG, and output in the HDF RIS24 file format for transfer to the LAM.

Each LPS-produced multiband scene browse is also identified in the metadata file associated with its ETM+ Format 1 subinterval. An LPS multiband scene browse image is generated from the three predefined ETM+ Format 1 bands (1 through 5 only). LPS does not generate multiband scene browse images for the ETM+ Format 2 bands (6, 7, and 8).

This section provides specific details on the multiband scene browse image (HDF RIS24 file) generated by the LPS. Figure 3-6 provides an overview of the LPS-produced multiband scene browse image for SLC-on data.

3.3.1 Multiband Browse File Overview

3.3.1.1 SLC-on Multiband Browse

An LPS SLC-on multiband scene browse file consists of an HDF RIS24 image object and ancillary information on the source (Format 1) band data, band data reduction, linear contrast stretch, and multiband scene browse labeling. A multiband scene browse, produced from a set of three predefined Format 1 bands (5,4,3), consists of a 24-bit raster image (RIS24), which is interleaved by pixel (DFIL_PIXEL) and reduced to approximately 185 KB after HDF JPEG compression. The resulting multiband scene browse image has the same aspect ratio as the source Format 1 band arrays. The output size of the multiband scene browse image depends upon the size of the WRS scene (operational parameters) defined in the LPS. The nominal size of a WRS scene in LPS (using Format 1 Bands 1–5) is expected to be 6,600 pixels (number of bytes in a scan line) x 6,000 scan lines (Section 3.1.1.2).

The LPS uses three Wavelet runs (a reduction factor of 64) for reducing each radiometrically calibrated Format 1 band image array to an 825 pixels (bytes) x 750 lines reduced-size band image array. Figure 3-6 provides an interim view of the LPS multiband scene browse image consisting of three reduced size band image arrays. After completion of the three Wavelet runs, the size of the reduced size three-band image array is approximately 1.86 MB. Next, the LPS applies a standard contrast stretch to each band of the reduced size band image arrays. This is only done on day scenes (as distinguished by the day/night flag, which can be found in the metadata file). The LPS uses a saturating linear contrast stretch for the LPS multiband scene browse images. The saturating linear contrast stretch algorithm nominally clips the upper and lower 2.5% from the reduced size band image's (array's) contrast distribution. The contrast clipping percentiles used in the generation of an LPS output multiband scene browse image are noted in its annotation (Table 3-23).

The LPS merges the three reduced size and linearly contrast stretched band image arrays by pixel interleaving (HDF DFIL_PIXEL). The LPS then uses HDF JPEG (compression utility) to compress the reduced band image arrays to approximately 185 KB. The JPEG compression step produces a multiband scene browse image in HDF RIS24 format.

The LPS may receive partial WRS scenes (with fewer than 6,000 scan data lines) at the start or end of a subinterval. A partial WRS scene is treated similar to a full WRS scene for generating a multiband scene browse. The partial WRS scenes in the band files are not filled to the full length of the WRS scenes. Also, the LPS does not insert any fill data above or below the partial WRS scene band data before generating the multiband scene browse. The multiband scene browse image for a partial WRS scene is thus constructed from the actual band data only.

Table 3-22 and Table 3-23 contain data reduction, linear contrast stretch and data compression parameters, and labeling information associated with the LPS-produced multiband scene browse HDF RIS24 object. Data reduction, linear contrast stretch, and JPEG data compression parameters are predefined and can be modified only with the consent of the Configuration Control Board. Only one multiband scene browse image (one HDF object) is included in an HDF RIS24 file. The source WRS scene (partial or full) used in generating a multiband scene browse image determines the RIS24 file size.

3.3.1.2 SLC-off Multiband Browse

The LPS SLC-off multiband scene browse file illustrates the geometric effect of the failed SLC, and is the same format as the SLC-on browse file. The browse content is different, as it is a slightly higher resolution browse image. The multiband scene browse consists of an HDF RIS24 image object and ancillary information on the source (Format 1) band data, band data reduction, linear contrast stretch, and multiband scene browse labeling. A multiband scene browse, produced from a set of three predefined Format 1 bands (5,4,3), consists of a 24-bit raster image (RIS24), which is interleaved by pixel (DFIL_PIXEL) and reduced to approximately 260 KB after HDF JPEG compression. The resulting multiband scene browse image has the same aspect ratio as the source Format 1 band arrays. The output size of the multiband scene browse image depends upon the size of the WRS scene (operational parameters) defined in the LPS. The nominal size of a WRS scene in LPS (using Format 1 Bands 1–5) is expected to be 6,600 pixels (number of bytes in a scan line) x 6,000 scan lines (Section 3.1.1.2).

The LPS applies a standard contrast stretch to each selected Format 1 full resolution band of the radiometrically corrected image. This is only done on day scenes (as distinguished by the day/night flag, which is found in the metadata file). The LPS uses a saturating linear contrast stretch for the LPS multiband scene browse images. The saturating linear contrast stretch algorithm nominally clips the upper and lower 2.5% from the full resolution image's (array's) contrast distribution. The contrast clipping percentiles used in the generation of an LPS output multiband scene browse image are noted in its annotation (Table 3-23).

The LPS then applies a simple model of the SLC-off scan geometry to the full resolution, radiometrically corrected, contrast-enhanced image array in order to provide a depiction of the scan gap locations. This model takes the form of a linear along-track pixel shift that introduces a total along-track offset of 14 image lines from one end of each scan to the other. This shift is implemented as a sequence of whole line offsets

ranging from -7 lines at the beginning of each scan to +7 lines at the end of scan. The integer line offsets are applied to 16-line (one scan) blocks of pixels in fixed along-scan pixel regions such that the integer shift corresponds to the nominal along-track effect of spacecraft motion over that pixel range, rounded to the nearest whole image line.

The SLC-off resolution reduction is then applied in two stages. First, a 3-times average and subsample reduction is applied. The pixel values in each 3-by-3-pixel area are added, divided by 9, and rounded to the nearest integer value. This 3-times reduced image is then passed to the Wavelet reduction routine for a further 2-times reduction. The result of this "hybrid" resolution reduction is a 6-times reduced version of the original image. This reduction produces a reduced size band image array of 1100 pixels (bytes) x 1000 lines, with the size of the three-band image array approximately 3.1 MB. The LPS merges the three reduced size band image arrays by pixel interleaving (HDF DFIL_PIXEL). The LPS then uses HDF JPEG (compression utility) to compress the reduced band image arrays to approximately 260 KB. The JPEG compression step produces a multiband scene browse image in HDF RIS24 format.

The LPS may receive partial WRS scenes (with fewer than 6,000 scan data lines) at the start or end of a subinterval. A partial WRS scene is treated similar to a full WRS scene for generating a multiband scene browse. The partial WRS scenes in the band files are not filled to the full length of the WRS scenes. Also, the LPS does not insert any fill data above or below the partial WRS scene band data before generating the multiband scene browse. The multiband scene browse image for a partial WRS scene is thus constructed from the actual band data only.

Table 3-22 and Table 3-23 contain data reduction, linear contrast stretch and data compression parameters, and labeling information associated with the LPS-produced multiband scene browse HDF RIS24 object. Data reduction, linear contrast stretch, and JPEG data compression parameters are predefined and can be modified only with the consent of the Configuration Control Board. Only one multiband scene browse image (one HDF object) is included in an HDF RIS24 file. The source WRS scene (partial or full) used in generating a multiband scene browse image determines the RIS24 file size.

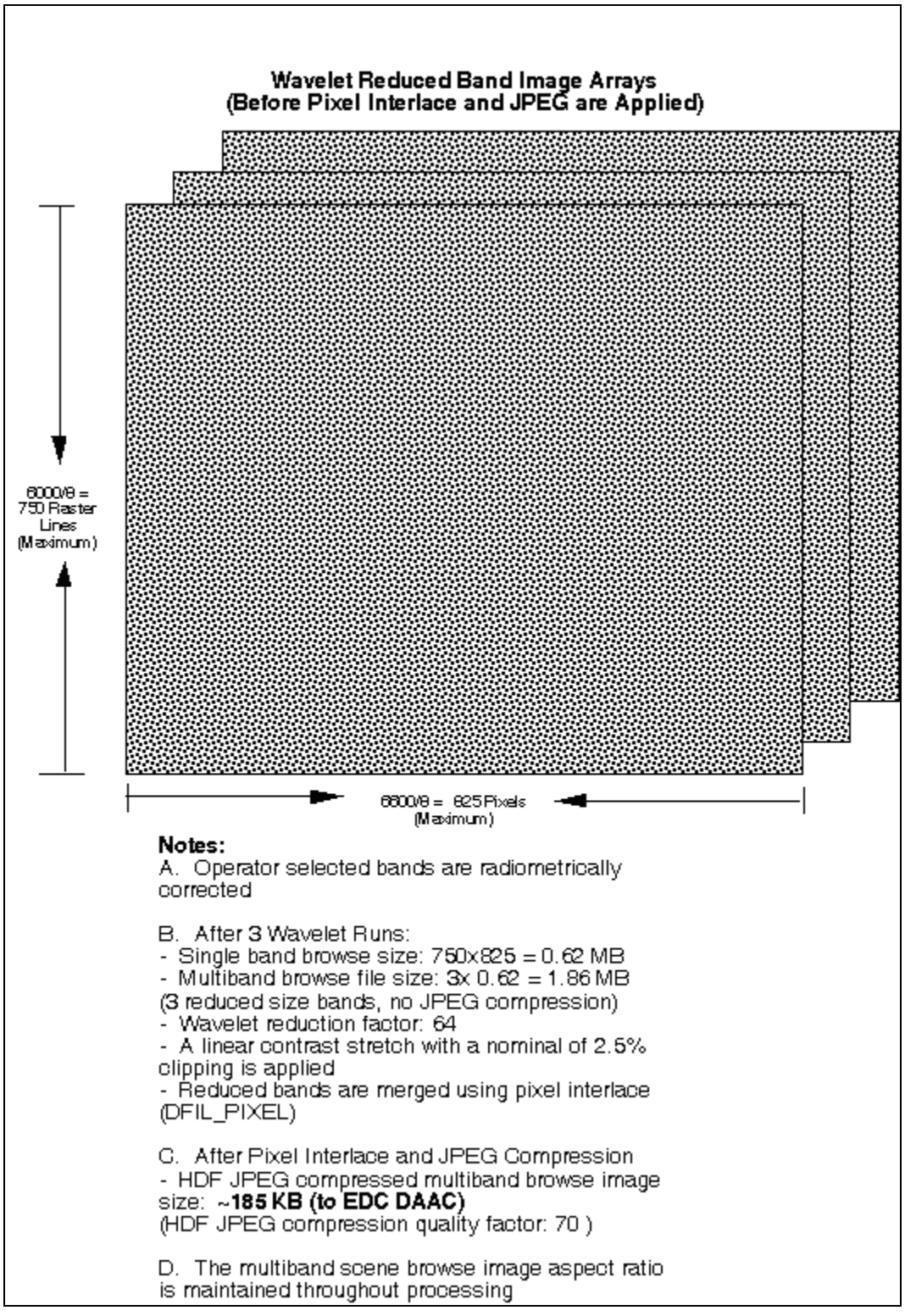

Figure 3-6. Multiband scene browse RIS24 File

RIS24 Object Definition Parameters	Type	Size	Values, Format, Range and Units	Parameter Description / Remarks
image_file_name	char8	22	= L7XsssfnYYDOYHHuuv.xxx where xxx = "R"nn and, nn = 01–99 "R" indicates a multiband scene browse file.	Section 2.4 provides complete details on the LPS file naming convention. At present, approximately 35 multiband scene browses are expected in a 14-minute long subinterval.
image_dimension_ width	int32	1	= 825 – for SLC-on = 1100 – for SLC-off pixels per scan line in each image plane	Based on a scan line length of 6,600 pixels/bytes (Section 3.1.1.2)
image_dimension_ height	int32	1	= 750 – For SLC-on =1000 – for SLC-off scan lines in each image plane	Based on a WRS scene size of 6,000 scan lines, including scene overlaps (Section 3.1.1.2).
image_dimension_ depth	int32	1	= 3	Implies 3 byte deep pixels for a 3 (multi) band scene browse.
image_interlace_il	int32	1	= DFIL_PIXEL (HDF uses an int32 type JPEG code)	Interlace by pixel (DFIL_PIXEL) is the default interlace mode for reading RIS24 images using HDF utilities.
image_ compression	int32	8	= COMP_JPEG (HDF uses an int32 type JPEG code)	The LPS uses HDF JPEG to further compress the multiband scene browse file size before sending it to the LAM for storage.
compression_ quality_ factor	N/A	1	= 70	The compression factor used by JPEG compression routine.

Table 3-22. Multiband Browse File - HDF RIS24 Object Definition (Parameter Values)

RIS24 Object Annotation Information ** Multiband Browse ASCII Text lines are shown in ** double quotes. Omit in HDF implementation.	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
ref_metadata_file_name	22	=L7XsssfnYYDOYHHuuv.xxx where xxx = "MTA"	See Section 2.4 for details on the LPS file naming convention.
band_Ids	3	= RGB where R = 1–5, G = 1–5, and B = 1–5	The three ETM+ Format 1 bands (each being 1 of the 5) selected for generating the multiband scene browse. LPS operation may assign three ETM+ bands as the default bands for browse generation.
wavelet_runs	1	= 3 – for SLC-on = 1 – for SLC-off	The number of Wavelet runs used to generate the multiband scene browse. Each run reduces the input image size to 1/4th.
clipping_percentile_top	4	= 0 - 50% Nominally set to 2.5% (Default) for a linear contrast stretch.	A predefined percentile value used in clipping the top (near 255) end of the multiband scene browse contrast values. This value is also used by the LPS in determining and applying a linear contrast stretch to the remaining distribution of the image contrast values.
clipping_percentile_bottom	4	= 0 - 50% Nominally set to 2.5% (Default) for a linear contrast stretch.	A predefined percentile value used in clipping the bottom (near 0) end of the multiband scene browse contrast values. This value is also used by the LPS in determining and applying a linear contrast stretch to the remaining distribution of the image contrast values.

Table 3-23. Multiband Browse RIS24 File Label and Object Description

Appendix A Glossary

Landsat 7 Contact Period: The time duration between the start and end of raw wideband data transmissions from the Landsat 7 spacecraft to a ground station [e.g., the Landsat 7 Ground Station (LGS). Figure A-1 illustrates the Landsat 7 contact period concept.

Interval: The time duration between the start and end of an imaging operation (land observation) by the ETM+ instrument on board the Landsat 7 spacecraft. The raw wideband data collected during an interval consists of a contiguous set of WRS scenes.

Subinterval: A segment of a raw wideband data interval received during a Landsat 7 contact period. Subintervals are caused by breaks in the wideband data stream due to communication dropouts and/or the inability of the spacecraft to transmit a complete observation (interval) within a single Landsat 7 contact period. The largest possible subinterval can be as long as a full imaging interval (a set of contiguous WRS scenes) transmitted during an uninterrupted contact period. The smallest possible subinterval can be as small as a set of a few contiguous ETM+ scans (a partial WRS scene). The smallest size of a subinterval is an operator modifiable parameter in LPS. If the smallest subinterval size is chosen to be as long as a full WRS scene, it will contain approximately 24 seconds worth of ETM+ data or 335 scans (without the 20 overlapping scans each, at top and bottom, between adjacent scenes). The ETM+ raw wideband data, collected for a single imaging observation by the Landsat 7 spacecraft, is received in two parts, ETM+ Format 1 and ETM+ Format 2, by the LPS. The LPS produces a separate subinterval (part) for each ETM+ format. Figure A-1 illustrates the subinterval concept.

ETM+ Format 1: The ETM+ Format 1 major frames contain all data (e.g., imaging and calibration) from and associated with Bands 1–6. The MSCD and PCD data are duplicated in both ETM+ formats.

ETM+ Format 2: The ETM+ Format 2 major frames contain all data (e.g., imaging and calibration) from and associated with Bands 6–8. The MSCD and PCD data are duplicated in both ETM+ formats.

LPS String: A functional and physical entity of the LPS responsible for the end-to-end processing of Format 1 and Format 2 ETM+ raw wideband data received via a return link channel (I or Q) of an X-band downlink from the LGS via the DCS.

LPS (output) Files: The generic term used to denote the grouping of Level 0Ra, browse, and metadata files for a single subinterval. L0Ra files contain image data, cal data, PCD, and MSCD. Multiband browse scenes file and metadata file consisting of L0Ra QW&A data are contained in the LPS Output File Set.

Level 0Ra Files: The generic term used to denote the grouping of band, MSCD, PCD, and calibration data files for a single subinterval.

Level 0Ra Quality and Accounting Data: The data quality and accounting information collected by the LPS, on a subinterval basis, from processing of the ETM+ major frames constructed from the wideband Virtual Channel Data Units (VCDUs) received during a Landsat 7 contact period.

Scan: A scan results from a cross-track motion of the ETM+ instrument and consists of detector-sensed data from all bands. Each of the ETM+ Bands 1 through 5 and 7 produce 16 detector data lines during each scan. Bands 6 and 8 produce 8 and 32 detector data lines during each scan.

Scan Line: An image data line produced from a single detector of a band during a scan.

Upper Corners: The upper corners of a scene are the corners associated with the trailing edge (first scan) of a scene. For descending path scenes, the upper left corner corresponds to the north-west corner of a scene and the upper right corner corresponds to the north-east corner of a scene. For ascending path scenes, the upper left corner corresponds to the south-east corner of a scene and the upper right corner corresponds to the south-west corner of a scene. These mappings hold for the band file geolocation fields and the metadata file. See Figure A-2 and Figure A-3 for the context of the corners with respect to the spacecraft and the image display.

Lower Corners: The lower corners of a scene are the corners associated with the leading edge (last scan) of a scene. For descending path scenes, the lower left corner corresponds to the south-west corner of a scene and the lower right corner corresponds to the south-east corner of a scene. For ascending path scenes, the lower left corner corresponds to the north-east corner of a scene and the lower right corner corresponds to the north-west corner of a scene. These mappings hold for the band file geolocation fields and the metadata file. See Figure A-2 and Figure A-3 for the context of the corners with respect to the spacecraft and the image display.

Full WRS Scene: A full WRS scene with overlap is defined to be 375 ETM+ scans. A nominal scene without overlap was defined to be 335 ETM+ scans. Due to a movement of the bumpers, which resulted in a larger turnaround interval and an increase in the nominal number of minor frames per major frame from 7,423 to 7,473 the nominal size of a scene without overlap may decrease. Further bumper wear changes may decrease the number of scans without overlap further. The number of overlap scans will increase to compensate for the decrease in the non-overlap scene size.

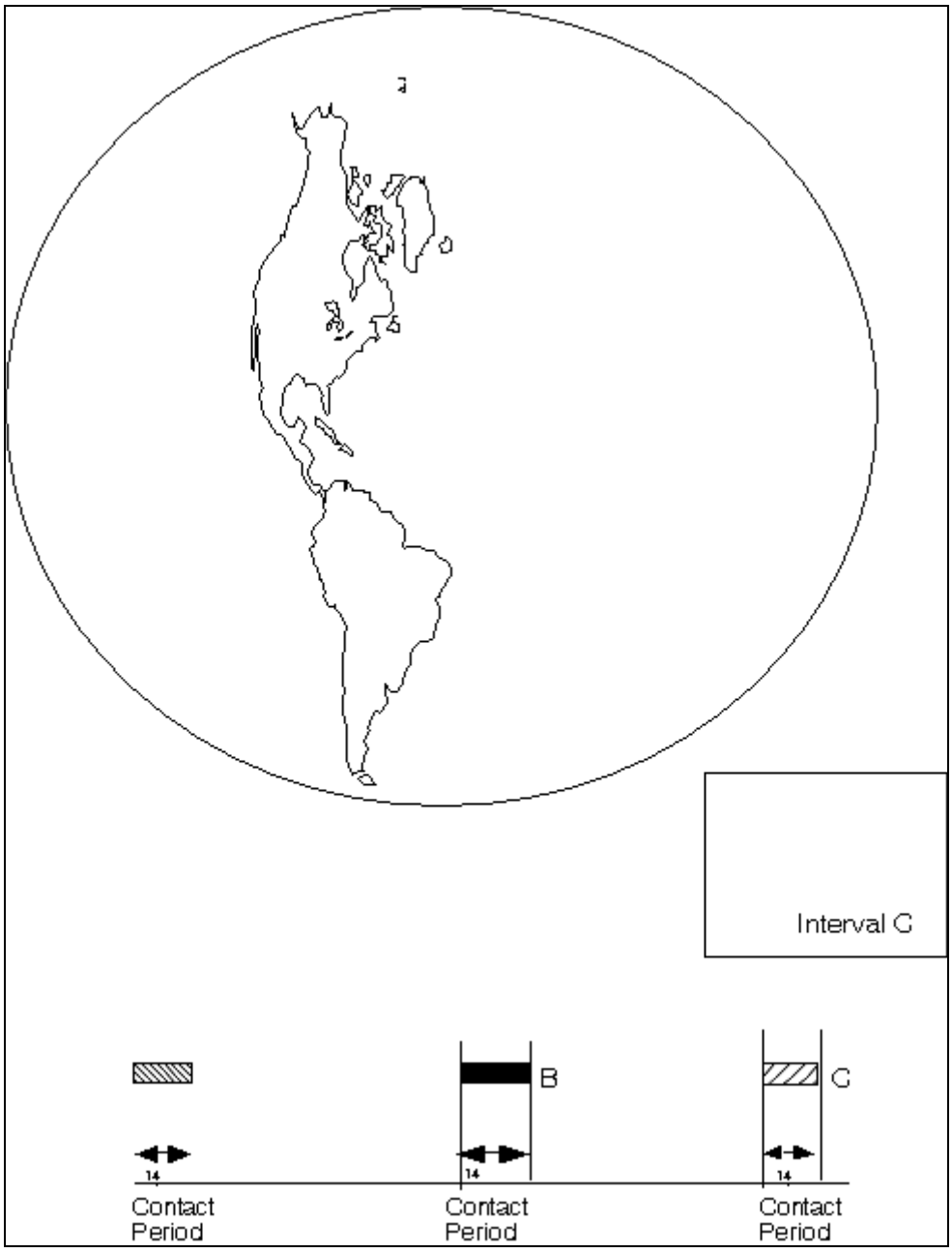

Figure A-1. Real-Time Imaging Mapped to Ground

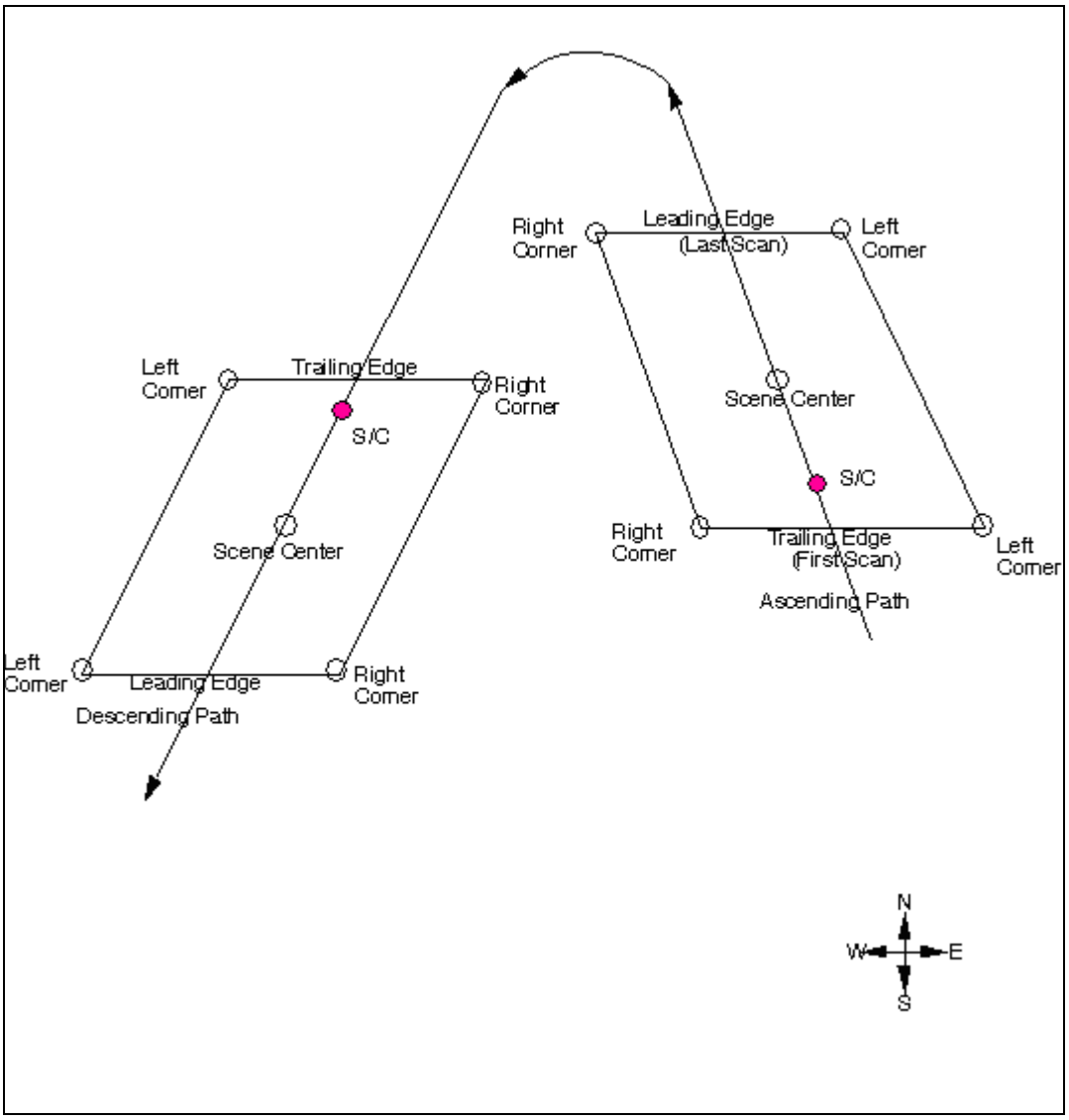

Figure A-2. WRS Scene Corners Context (1 of 2)

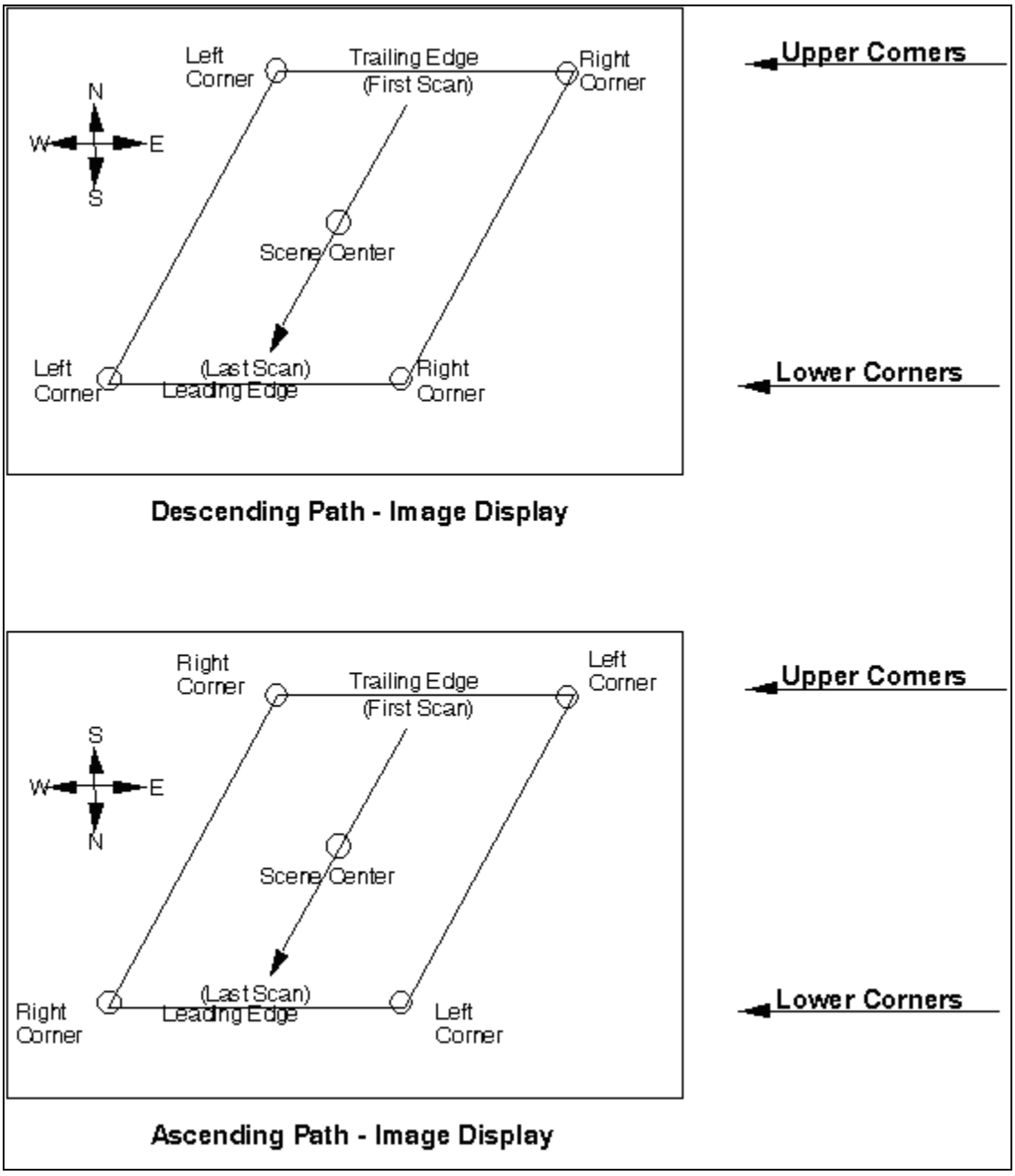

Figure A-3. WRS Scene Corners Context (2 of 2)

Appendix B Acronyms

ASCII	American Standard Code for Information Interchange
BCH	Bose-Chaudhuri-Hocquenghem Error Detection and Correction
CADU	Channel Access Data Unit
CCSDS	Consultative Committee on Space Data Systems
D/L	Downlink
DCPF	Data Capture and Processing Facility
DCS	Data Capture System
DFCB	Data Format Control Book
DLT	Digital Linear Tape
EDC	EROS Data Center
EOL	End of Line
EOS	Earth Observing System
EROS	Earth Resource Observation System
ETM+	Enhanced Thematic Mapper Plus
EU	Engineering Units
FHS ERR	First Half Scan Error
FTP	File Transfer Protocol
GB	Gigabytes
GMT	Greenwich Mean Time
GSFC	Goddard Space Flight Center
GST	Ground Station Technician
HDF	Hierarchal Data Format
HDF-EOS	Hierarchal Data Format - Earth Observing System
IAS	Image Assessment System
ICD	Interface Control Document
IGS	International Ground Station
JPEG	Joint Photographic Experts Group
L0Ra	Level 0 Reformatted Archive
L1	Level 1

L1G	Level 1 Geometrically Corrected
L1R	Level 1 Radiometrically Corrected
LAM	Landsat Archive Manager
LAM AS	Landsat Archive Manager Archive Server
LGS	Landsat 7 Ground System
LHS	Left Hand Side
LPGS	Landsat Product Generation System
LPS	Landsat 7 Processing System
LSC	Line Sync Code
MB	Megabyte
MMO	Mission Management Office
MOC	Mission Operation Center
MSCD	Mirror Scan Correction Data
NCSA	National Center for Supercomputing Applications
ODL	Object Description Language
PCD	Payload Correction Data
PTP	Programmable Telemetry Processor
RAID	Redundant Array of Independent Drives
RF	Radio Frequency
RHS	Right Hand Side
SAIC	Science Applications International Corporation
SCC	System Control Center
SCN DIR	Scan Direction
SGI	Silicon Graphics Inc.
SLC	Scan Line Corrector
SLC-off	Scan Line Corrector-off
SLD	Scan Line Data
SRD	System Requirements Document
TT&C	Telemetry Tracking and Control
U/L	Uplink
USGS	United States Geological Survey

VCDU	Virtual Channel Data Unit

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